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Double Surface Grinder.

The illustration on this page is of a grinding machine for producing plain surfaces, the work being placed either upon a rotary or upon a reciprocating table.

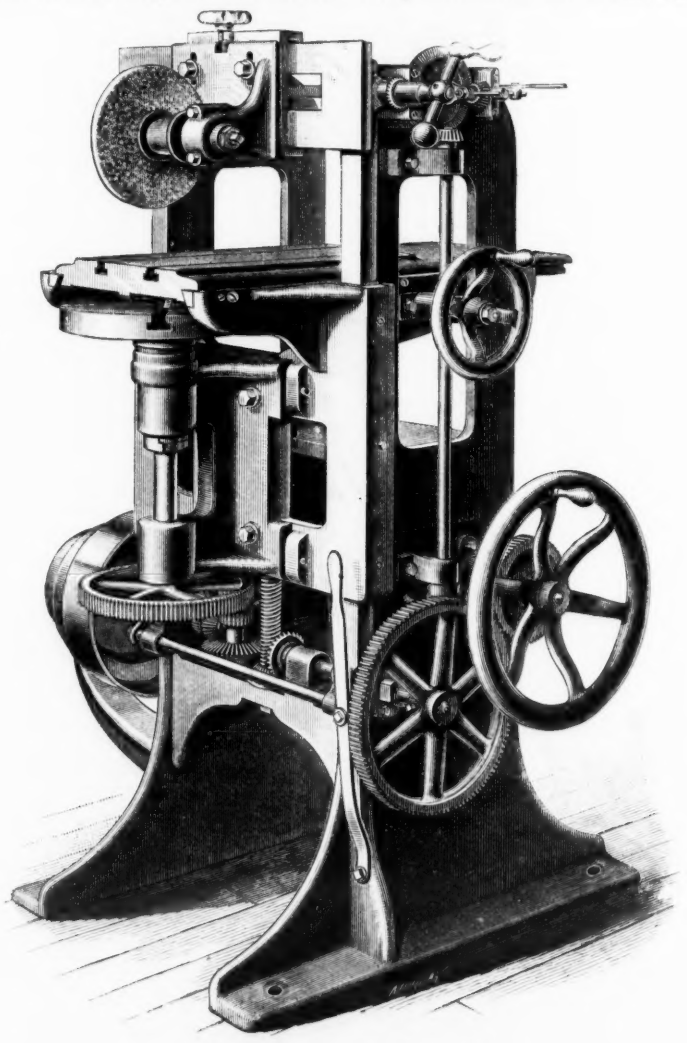
The construction and method of operation of the machine will be readily understood by an inspection of the engraving, where it is seen that the sliding table is moved by a rack and pinion motion, and is preferably manipulated by hand.

The rotary table is driven by means of the gears shown and both tables are adjusted vertically by the large hand-wheel seen at the right of the machine. When the rotary table is in use the sliding table is simply run back on the extended ways so that it does not interfere.

The wheel carriage, or saddle, has a slight vertical adjustment, and a continuous automatic feed in either direction. The cross rail upon which it slides is bolted to the frame of the machine and can easily be removed for truing up when necessary.

The sliding table also rests upon removable strips, which are easily trued up when worn, and are adjustable.

The rotary table is 11¼ inches diameter, and the sliding table will take a die or other piece of work 16 inches wide, 10 inches high. Centers can be bolted to the plain table for grinding taps, reamers, etc., and chucks or special fixtures of any kind are readily attached to either table. It is made by G. E Whitehead, 621 Broadway, Providence, R I.



DOUBLE SURFACE GRINDER.

Standards—Steam Engine Power—Sawing Stone.

BY W. H. BOOTH.

With all the high talk of uniformity in standards, there is really very little uniformity as between one workshop and another, though it is within the power of all workshops to use accurate means of measurement. As an example of this want of interchangeableness between different shops, let me cite an instance.

Some weeks ago I ordered a piece of 1¾ steel shafting from regular makers of mill gearing, whom I will call A. I had by me a 2¼ shaft by a firm, B. Three days ago I ordered two pulleys to fit these two shafts from firm A., making no reference to their destination, but simply quoting the bored sizes, 1¾ inches and 2¼ inches. Now, the 1¾ inch pulley was a perfect fit upon the 1¾-inch shaft, that is to say, when held square, and steadily pushed on the shaft it went on easily, but cleaned off the oil as nearly dry as possible. This showed me that the firm A. have at least a perfect system as regards their own shop, their turning and boring gauges being in correct proportion. I learned, also, that, though firm B. also, no doubt, have as good a system in their own works, yet one not in agreement with that of firm A for the 2¼ bore pulley would not even begin to go on the 2¼-inch shaft. It may be that one firm bore their pulleys to the nominal size, and turn the fit *off* the shafts, while the other firm turn their shafting to size, and bore the fit out of the pulleys. Anyway, the difference is there, and it appears to me it would be just as easy were each maker to both turn smaller and bore larger than the nominal size by just the half of the margin, they now throw all into one operation only; to make the two dimensions, in fact, $2 + x$ and $2 - x$, instead of 2 and $2 + 2\ x$, or 2 and $2 - 2\ x$. A builder of machinery, who in these days of specialism naturally wishes to have his various workshops scattered all over the country, wishes all parts to come together with accuracy. That they were made in shops hundreds of miles apart is no more reason for want of fit than if each shop were under my own particular orders. It is something to have got down to standards in screw threads—they do not yet have a standard thread in France, but there should be standards for keys, and I do not think any serious harm would be done if the simple rule of key breadth equals one fourth the shaft diameter were adopted. There are rules for keys which consider the wheel or pulley diameter. I cannot see that the diameter has anything whatever to do with the key breadth, for, no matter what the wheel, the shaft, properly loaded, has always the same twisting moment exerted upon it, and, therefore, the key that is strong enough for a 12 inch pulley on a 2-inch shaft, is strong enough for a 24 inch pulley, only the 24-inch pulley should only be half as wide as the 12 inch pulley. There are always such wide margins in all mechanical work that a very large proportion of the dimensions of machinery are designed with a factor of convenience—a manufacturing factor which will often contrive that one detail shall serve two or more sizes in a line of goods. One man may use no shafting less than 1½ inches diameter, and nothing larger than 3 inches diameter, and will vary the sizes by a quarter of an inch at a step. He has, therefore, seven sizes to choose from, and if he makes twelve sizes of a given machine, his shafting must be out of proportion in five of them at least. And so, also, in other details. One soon learns that machine design is not always a question of strength or economy of material, but that prices, and even the size of one's machine tools, enter into consideration. The combination of a cheap and a costly material in one article once so common, is not always an economy where the combination demands labor and machine work, and where the cost per pound of the more costly material is much greater for a small mass than it is for a large mass.

I am continually being annoyed by the use of the term rated horse-power as applied to steam boilers. Years ago the term nominal horse-power became useless, and it has become comparatively infrequent, and then there grew up the new term of rated horse-power which appears to be the power of evaporation of a boiler divided by the number thirty, such number thirty being supposed to be the water consumption of a steam engine per horse-power indicated. Surely the newer term is more misleading than the older. By nominal we do understand something that is not what it professes to be, but by rated horse-power one is apt to think of something actual. Now, the rated horse-power of a boiler means nothing. A man was recently bragging about the excellence of a boiler. He claimed for it that it frequently gave a horse-power 50 per cent. more than its rated capacity. This looked well, but it turned out that it was rated as so many horse-power on the 30-pound basis, and was driving engines whose water consumption is 13 to 18 pounds. Unless, therefore, to the expression rated horse-power be added the explanatory words giving the number of pounds of water per horse-power we ought to demand the disuse of the word horse-power as applied to boilers. The working capacity of a boiler is very much a question of grate surface and in estimating what horse-power a boiler will serve with steam it is better to take no thought of its rating but to assume a suitable coal consumption per square foot of grate, say, 20 pounds, an evaporation of 10 pounds per pound of coal, or such other rate as experience tells us the coal will do, and a grate surface, not necessarily that of the boiler maker, but such as we are taught by experience is suitable. Makers are apt to supply fire grates too long, and the result is that proper attention cannot be given to them and wastefulness results. For these and kindred reasons it seems undesirable that a boiler should be rated in horse-power seeing that with every improvement in the steam engine the "power" of the boiler is really increased, and to-day we find establishments with engines of a thousand horse-power, and only as many boilers as we can remember were once attached to four or five hundred horse engines.

Having recently to provide in a hurry some pumping machinery and an engine to work same temporarily, I purchased a second-hand engine of light appearance, after satisfying myself as to its cylinder dimensions, it figured out with the pressure of the boiler, to be capable of indicating at a reasonable cut-off for a temporary engine, viz.: half stroke, just about three times the horse-power of the theoretical work, in foot-pounds, to be done, and in this I had a margin in the boiler pressure and also in the cut-off, and was therefore safe, and yet the very light build of the engine was sufficient to throw very grave doubts upon its capacity for doing the necessary duty for which it was ample even with an allowance of 100 per cent. for friction. Now, I have used this same class of engine before with satisfactory results and have had the same fears expressed, even by men who profess to be mechanical engineers, that the engine would not do its work. They did not merely say that they considered the engine to be too light for the stresses that would be produced in its parts by the steam pressure. I could have forgiven them that; they denied its capacity to revolve against the resistance of the work to be done, and it was useless to state the cylinder diameter, the stroke and the pressure, and to give them the number of gallons that would be pumped at a given number of revolutions and the height of lift. All these figures were of no account to them; they would only take account of the appearance of the framing. Experience has proved this framing to be ample, and yet so-called engineers will use

it as a measure of power ignoring the piston area. Does not this show how much there may be in mere outside show, and explain how it is that a poor machine or a tool will sell where a good one goes begging? There may, after all, be something at the bottom of the wonderful color effects so much associated with agricultural machinery, and also in odd shapes given to framings meant for sale to people whose eye has not been mechanically trained.

One thing about the purchase of small steam engines, be sure that the steam passage areas are sufficient; then go ahead and rely upon it you will get the power according to cylinder, size and pressure, making good allowance for the friction of the engine itself. This is apt to be considerable in small engines and accounts for the rapid augmentation of the power of these small engines with each addition of boiler pressure. The engine absorbs nothing of the additional pressure, which therefore all passes into the belt as power, so that an engine quite weak at 20 pounds pressure becomes quite powerful at even 25 pounds, and if by trial we know the frictional boiler pressure or, better still, the mean pressure of the friction diagram, we can readily figure the surplus or power that we can obtain from any pressure higher than this. I would suggest to small engine makers of the fixed cut-off single valve type that they give the point of cut off in their descriptive catalogues and the boiler pressure that will just drive the engine at its proper speed with full open throttle, and that they should omit all rating in horse-power.

They might, however, state that the engine will produce so many brake horse-power for each 10 pounds of pressure above 5 pounds or 10 pounds, or such boiler pressure as is required to drive the unloaded engine.

My experience tells me that men of good knowledge, but not specially conversant with steam engines, are quite unable to arrive at satisfactory conclusions in purchasing from an ordinary catalogue description. As a result they will order one size larger than what they think will do, and are never certain they have a big enough engine till they have proved it. And so they waste money for want of a direct statement in the maker's catalogue. A steam engine maker who sells too big an engine to his customer is quite as much of a fraud as he who steals $\frac{1}{8}$ inch off the cylinder diameter and $\frac{1}{4}$ inch off the stroke, for an engine too large is always wasting steam and costing extra in the interest of the first cost.

As showing what a small thing may effect a marked economy, I would mention that when visiting some large quarries and stone sawing works I found that the stone frames had been very considerably improved in their output by the addition of a small centrifugal pump, which pumped up water and sand and distributed this continuously and regularly to the saws in place of leaving this duty to be performed by the water tap and shovel. The pump simply kept the sandy mixture in constant circulation, an occasional shovelful of fresh sand being placed in the pit below the frames and finding its way gradually to the pump. Fresh water was run in to keep up the solution to a freely liquid state, and the worn out sand levigated off above a weir board. The regularity of the supply of grinding material added not only to the rate of cut, which was about $2\frac{1}{2}$ inches per hour in dense carboniferous rocks, but it added also to the life of the saws. The saws are simply strips of the commonest iron, about $\frac{3}{16}$ inch thick, and when new 5 inches wide. They have no teeth, but the place of teeth is taken by the grains of sand washed in by the water. They are worked until they are reduced to a breadth of about $1\frac{1}{4}$ inches and then sold to be punched into washers for bolts, whilst the waste sand commands a sale for mortar. Though so hard and dense the rough blocks of stone are trimmed to size and squared up for the saws in a kind of planer, consisting of a carriage traveling to and fro with the rough block and three tool bars, these latter, strong bars extending across the machine, one being horizontal above the work and the other two placed vertically on each side thereof. In these bars are fixed strong chisels about 2 inches wide, and with a gap between each and its neighbor about an inch wide. They project downwards at an angle of about 45 degrees, and are made to face both ways so as to cut in each direction of the block travel. The stock is removed in what are termed by quarrymen, "scapplings," the size of an open hand and $1\frac{1}{2}$ to 2 inches thick, and the scapplings sell for road foundations. There is very little waste in the business, anyhow, and the reversible chisel bearers struck one as rather notable in an apparently very rough machine. The centrifugal pumps in this case were American can in make, the quarry proprietor explained to me, and he was well satisfied with the results they were securing for him.

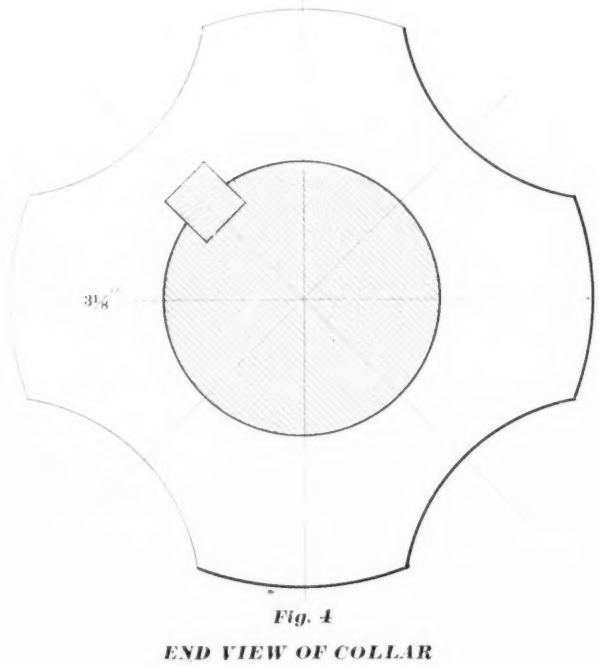


Fig. 4

END VIEW OF COLLAR

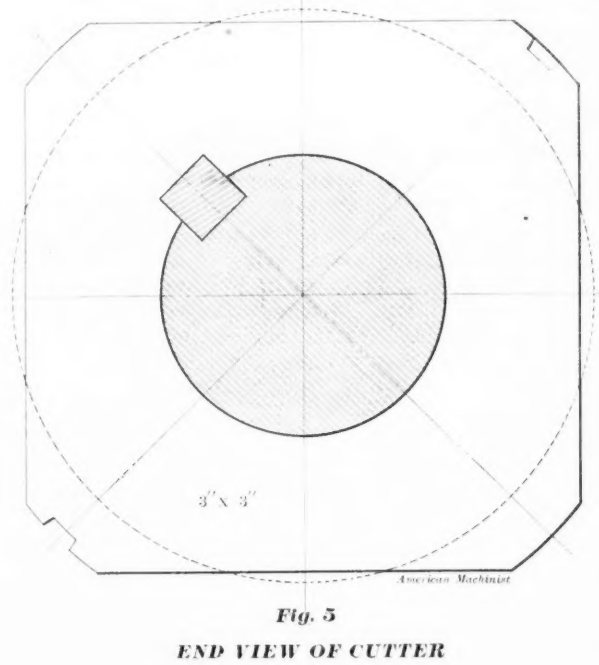


Fig. 5

END VIEW OF CUTTER

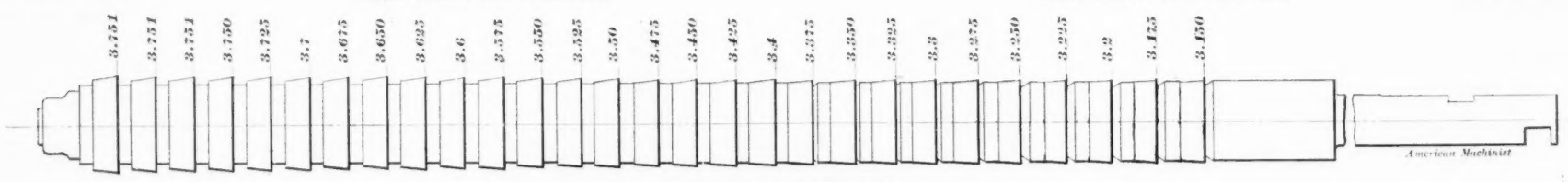


Fig. 2—VIEW OF CORNERS

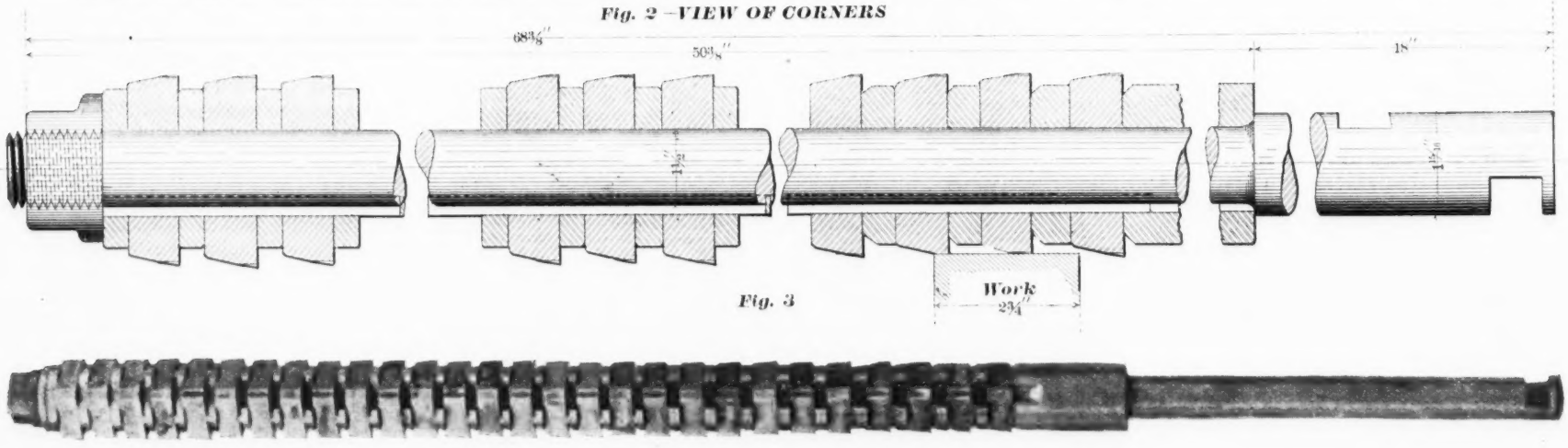


Fig. 3

A Remarkable Job of Broaching.

Most of our readers are more or less familiar with broaching operations, but a broach 5 feet 8⅜ inches long, weighing 112½ pounds, and made up of 58 distinct pieces, for broaching holes 3 inches square through 2¾ inches of cast-iron is not very common, to say the least; in fact, the mere mention of such a broach is calculated to give something of a shock to a tool maker. We have seen such a broach at work, however, and think some account of it and its working may prove interesting.

The broach was designed by Mr. John A. McGregor, of Edwin Harrington Son & Co., Philadelphia, and is for making a square hole in a chain sheave, which constitutes part of their improved hoist.

Most broaches are pushed through the work, but some experience of Mr. McGregor's having shown him that there were important advantages in pulling them through, it was arranged to do this job on a Knowles' key-seating machine, the essential features of which are, a horizontal bed in which is a slide moved by a heavy rack and pinion, the key-seating tool, or, in this case, the broach, being pulled through the hole, previously prepared for it, by attaching it to the end of this slide. In this case the hole is first bored and reamed in a chucking machine to 3⅛ inches diameter, and a steel bushing which is located on the shank of the broach in advance of the cutters is made to fit this hole with just sufficient clearance to pass through freely. The rest of the shank, which is 1½ inches diameter, is provided with a feather for properly locating the cutters, and, at the left, is threaded for a nut which holds cutters and collars firmly in place. The cutters and collars alternate upon the bar, the collars serving to separate the cutters, and give room for chips. Their most important function is, however, to keep the broach properly centered, and for this purpose they are all made of the same diameter and to fit the round hole in the work made before the broaching begins. At four points in their circumference they are cut away to make room for chips, as shown at Fig. 4, which is a cross section of the broach showing a collar in place, while Fig. 5 is the same, but shows one of the cutters, which is near the finishing or left hand end of the broach. Even the last collars to pass through the hole have a bearing in it for the reason that it is bored ⅛ inch larger than it is broached, thus leaving on each of the four sides a segment $\frac{1}{16}$ inch high and giving a bearing for the collars about $\frac{7}{8}$ inch wide.

All that part of the cutter which projects beyond the dotted circle, as shown at Fig. 5, represents the metal cut away by the passage of the broach, and an idea of the amount removed by each cutter can be obtained from the figures given in Fig. 2, which give the diameter of each cutter across the corners; the corners being ground to an arc of a circle, as shown at Fig. 5, and

having the corners diagonally opposite each other notched as shown. Each cutter has its notched corners so located that when in place upon the bar one cutter will be notched as shown, while the next one will be notched only upon the other two corners. The object of this notching is to lessen the strain of the cut on the same principle as is now employed with milling cutters.

In making this broach pains were taken to make the best possible job of it throughout, the collars being hardened and ground to size upon an arbor, and the cutters the same as regards the corners, the sides being ground upon a fixture made to be used upon the table of a surface grinder and which holds them upon an arbor, having a key by which they are properly located relatively, each to the others. Both cutters and collars are also accurately faced by grinding so that when tightened upon the bar it is not thrown out of truth.

In operation, the slide of the machine being run forward, the shank of the broach is passed through a wheel and locked to the slide by keys passing through the slots shown. The collars are oiled by a small brush dipped in oil, and the machine is then thrown into action, pulling the broach through. The wheel is then taken off and a quick traversing motion returns the slide. Though there is evidence of considerable force exerted to pull the broach through, the machine seems not to be unduly strained, and during a trial witnessed by the writer four wheels were broached in 25 minutes; two men being required to handle the broach.

It will be noticed that the last three cutters that pass through the work are all full size; which, of course, is to insure the maintenance of the standard. It is expected that a great many wheels can be broached without appreciable dulling of the cutters or loss of size, but when this does occur it will probably be necessary to provide only one new cutter, the others being ground sharp and to the proper size to be advanced one position on the bar. This easy maintenance of exact standard size is, we think, one of the best features resulting from this construction, and though this was, of course, an expensive broach to make, it is easily seen that it is a very efficient and economical tool for the purpose.

Sixteen-inch Shaper.

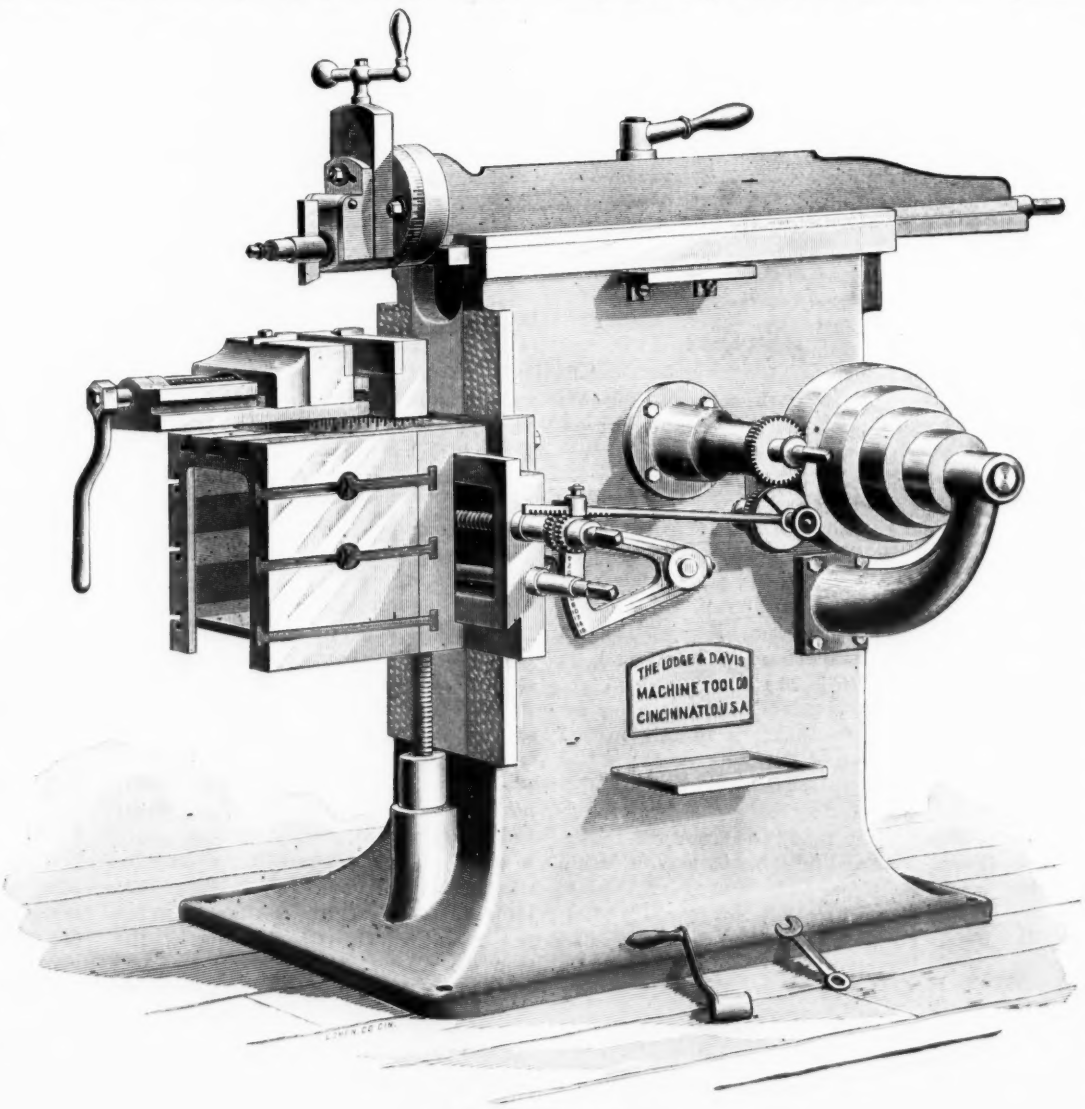
The illustration presented herewith is of a 16 inch pillar shaper, which employs the usual slotted lever for obtaining the quick return motion, and means are provided for taking up wear between the sliding block and slot. The upper end of the lever carries a roller which works in a slot formed in a nut which is fitted to slide upon the under surface of the ram and can be adjusted to any desired position while the machine is in motion for adjustment of the ram.

The length of stroke is adjusted by a screw which holds the crank-pin in any position without the necessity for locking it, and this can also be done while the machine is in motion, the graduated arc seen at the right of the machine having the same angular movement as the slotted lever, and plainly indicating the length of stroke for which the machine is set.

The rack which moves the feed pinion on the horizontal screw is so supported that it works the same regardless of the angle at which it stands, and it requires no attention or adjustment whatever when the cross-rail is moved up or down.

The cross feed screw can be operated from either end of the cross-rail, and the elevating screw is turned by applying the crank to the squared shaft at the right of the cross rail.

The table is detachable, and, when removed, leaves a surface to which work or special fixtures can be attached. Other features of the machine are indicated by the engraving. It is made by The Lodge & Davis Machine Tool Co., Cincinnati, O.



SIXTEEN-INCH SHAPER.

Makeshift Indexing.

BY OBERLIN SMITH.

The occult science of electricity has many mysteries. The not so-occult art of commercial electricity is also somewhat mysterious. Among the practical illustrations of the above proposition is the peculiar tendency that makers of dynamos and motors have for designing armature disks with outlandish and peculiar numbers of teeth, as 67, 89, 111, etc., instead of giving the tool makers whom they patronize specifications in such good, old-fashioned round numbers as would cause no increment of stress upon their brain tissue. This article seems to have started out to deal with the wonders of electricity, but the consideration of that subject must be "another story"—as Rudyard Kipling would say.

The text of this sermon was the ordering, upon a recent occasion, from a shop not a thousand miles from my office, of an indexing punching machine, one of whose component parts was a *dial*, made after the similitude of an ordinary cog wheel, with some extra blank space between its notches, whose function was the guidance and instruction, as to how far to jump, of certain armature disks while being punched with 113 slots each, that number of teeth, for some mysterious reason being considered the only and proper one by the designers. Now, a good gear-cutting machine, properly alive to all modern requirements, would, of course, divide a wheel into this number of teeth without question. By the law of the total depravity of inanimate things, however, as Gail Hamilton would express it, the only available machine was found to cut 112, 114 etc., but not the missing link between. The question arose, as it is constantly arising in any machine shop, what is the best *makeshift* for producing this particular piece of work, the like of which will never probably be wanted again? The machine was of that familiar type where the main indexing spindle has mounted upon it a large worm gear which is actuated by a single threaded worm revolved the proper amount, through the medium of change gears, by a hand crank which is indexed by slipping into a yielding notch once in each revolution—the various numbers of revolutions required being governed by the instructions stamped upon a permanent table attached to the machine.

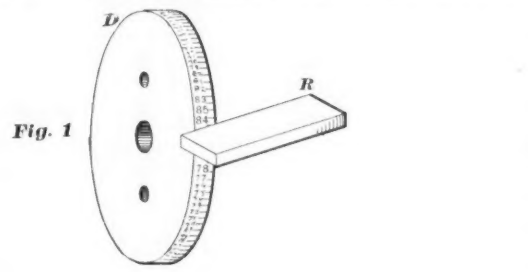


Fig. 1

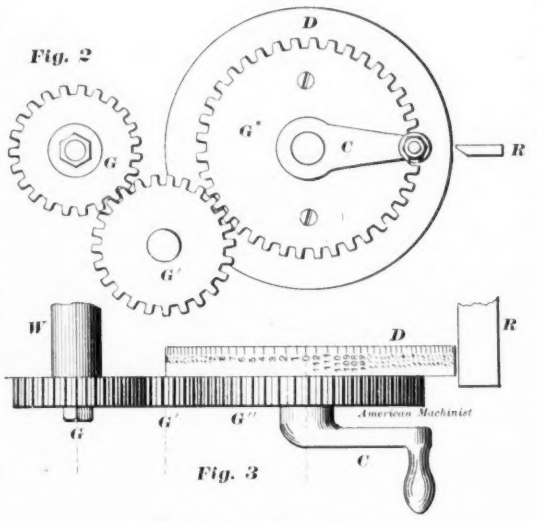


Fig. 2

Fig. 3

MAKESHIFT INDEXING.

As nearest adapted to this particular case, the instructions read: "112, 28, 60, 1," the first number referring to the required teeth to be cut, the second and third to the number of teeth of the respective change gears, and the last to the number of revolutions of the crank. The next line of the table ran: "114, 38, 80, 1," and there were no gears at hand which would give the desired number between the above sets of figures. Had the machine been of one of the older types, where a large dial wheel, perforated on the pepper-box principle, is made to do the dividing directly, the obvious makeshift device would have been a temporary dial of paper or other substance divided, by pencil-marks, into 113 parts, made of as large a diameter as possible, and attached for the time being to the regular dial. There would then, however, even with the utmost care, have been the double errors due to incorrect dividing, and to incorrect reading at each adjustment. These, moreover, would have counted at nearly their face value, so to speak—the accuracy, of course, depending upon the relative diameters of dial and work.

In the case in question, however, I took advantage of a certain differential principle which I have never before seen applied to a gear cutter in this way, and one by which errors of dividing and reading are in the present case reduced more than a hundred fold. All the special construction that was necessary was a roughly turned wooden wheel made out of a stray piece of inch board 9 inches in diameter, together with another little straight strip of board to be clamped near its periphery to serve as a reading mark; also a strip of cross-ruled drawing paper about 1 inch wide, pasted around the wheel's periphery, having its graduations numbered in pencil marks—113 of them. The wooden wheel could, of course, have been stepped off with a pair of dividers, and graduated with marks scribed directly upon it, no great accuracy being required. A much cheaper way, however, was to use the cross-ruled drawing paper above mentioned, because I always have plenty of it at hand, in lengths of three feet and below, and it is already graduated with heavy pink lines 1 inch apart, with lighter ones $\frac{1}{8}$ inch apart. All that was necessary was to take a piece containing 113 divisions, which, in this case, happened to be $\frac{1}{4}$ inch each, as this made the strip of paper 28$\frac{1}{4}$ inches long—about the circumference desired for the temporary dial. This strip being cut off the paper, the distance required was looked for in the circumference column of a book of tables. The nearest figures found were 28.27 inches, pertaining to a diameter of 9 inches, which happened to be only very slightly in excess of the diameter suiting the paper. The wheel was then turned roughly to 9 inches, and tentatively reduced in the lathe until the strip of paper exactly reached around it. Had there been a much larger number of divisions the $\frac{1}{8}$ inch graduations would probably have come into play, while, had the number been considerably smaller, $\frac{1}{2}$ inch or 1 inch might have proved more convenient. There was in the machine, however, a considerable margin in the possible size of the wheel—either up or down.

In the drawings, Fig. 1 is a perspective view of the dial and reading plate in question. Fig. 2 is an end view and Fig. 3 a top view of the small change gear G mounted upon worm shaft W, intermediate gear G', large change gear G'' with its attached crank C, and the makeshift dial D with its reading plate R. The latter could, of course, be clamped to any convenient part of the machine, so that its edge coincided with an element of the cylinder represented by the dial.

The action of this apparatus will to many persons be obvious, but may be described as follows: The change gears being set for normally cutting 114 teeth, it is evident that, by the table above quoted, one revolution of the crank would give $\frac{1}{114}$ revolution of the work to be cut. Reducing this fraction and the desired $\frac{1}{118}$ revolution to a common denominator, we have the machine normally giving $\frac{118}{13452}$, and the desired amount $\frac{114}{13452}$. It is therefore necessary at each tooth cut to revolve the crank once, plus enough more to give $\frac{4}{13452}$ of a revolution to the work. This increment is evidently obtained by $\frac{1}{118}$ of a crank revolution, because the ratio between these last two quantities is the same as that of the angular velocity of the work to that of the crank, namely 1 : 114. All we had to do, therefore, was to revolve the crank the normal one time, and one division upon the paper-covered dial extra. As a precaution to avoid errors on the part of the operator, to whom this performance was, of course, new, the penciled figures were not written on the dial, except one by one, as he used the graduations. Thus, every time he moved the crank he knew that he must bring it to the graduation next beyond his last penciled figure, and all he had to remember was to do the writing, which writing thus served as a check mark upon his work, keeping tally thereof, so to speak.

As intimated above, it is evident that a mere approximate accuracy upon this dial will give abundantly good results upon the work, as, in the case cited, an error of a whole sixteenth of a dial division, or $\frac{1}{64}$ inch (which is an amount greater than a decent workman could fairly be expected to make) would revolve the work wrongfully to the amount of $\frac{1}{30064}$ of a revolution. Now, as the work in question was about 20 inches in diameter the circumferential error in inches would have been approximately 63 times the last-mentioned sum, or about $\frac{63}{15000}$ of an inch only. With more care or a larger dial, this result would obviously be still better.

The general rule for marking the system in question is to make the wooden dials of any convenient size to suit the machine and graduate them, either upon the side or edge, into the same number of divisions as the required number of teeth to be cut in the work. The crank of the machine is then to be revolved a proper number of whole turns to give a result the nearest possible to the special one required, plus or minus a number of divisions representing inversely the difference between the two numbers—the one scheduled and the one required. Expressed algebraically, this rule may be formulated as below, letting

T = number of teeth machine is set for.
T' = number of teeth to be cut.
R = revolutions of crank for one tooth of T.
M = motion of crank for one tooth of T'.
D = one division of dial.

Then, when $T' < T$, we have $M = R + D(T - T')$.

And, when $T' > T$, $M = R - D(T' - T)$.

The somewhat elaborate description above given of so trivial an operation as the cutting of one small gear may seem rather out of proportion to its theme. It may be remembered, however, that my object is to practically illustrate a principle that may be usefully applied in various "rigged up" machine shop operations. Among such are the indexing of feed screws in planers, millers, and like machines, when used temporarily to get accurate measurements by assuming for them the functions of a micrometer—as in odd rack-cutting, etc.

No Bias.

Johnson—I have been chosen as arbitrator in the matter of those labor troubles on the X., Y. and Z. Road! Thompson—Why, you are a stockholder in that road. Johnson—That's just it. Everybody wanted a disinterested party, and the stockholders haven't received a dividend in fifteen years. —*Puck.*

Chasing.

By JOHN T. USHER.

Chasing is the art of finishing bronze composition and other soft metal art and ornamented work by means of scrapers, burnishers, and a variety of other instruments in the form of punches of different shapes and sizes, the metal being cut away from, or driven into the body of the work, and the design, if any, on the face of the punch transferred to the work by the action of the punch and hammer.

Though this art forms no part of the machinist's branch of mechanics, yet a knowledge of the chaser's tools and their application can be used to good advantage by the machinist in finishing ornate pattern and other work, almost to the entire exclusion of any other method, and also in finishing other work difficult of access by the ordinary methods.

Fig. 21 represents a number of different forms of the chaser's punch tools. The size of the faces of the punches varying from $\frac{1}{16}''$ x $\frac{1}{64}''$ to $\frac{1}{4}''$ x $\frac{3}{8}''$, and the length from 4 to 5 inches, according to the requirements and nature of the work.

No. 1 represents a loup tool, the face of which is egg-shaped, used for finishing the fillets in corners and along the abutting surfaces of the work.

No. 2. Planisher. For producing a smooth surface; generally used for finishing the recessed surfaces of work, such as shown on the under side of the pattern at $a\ a'$ (Figs. 22 and 23).

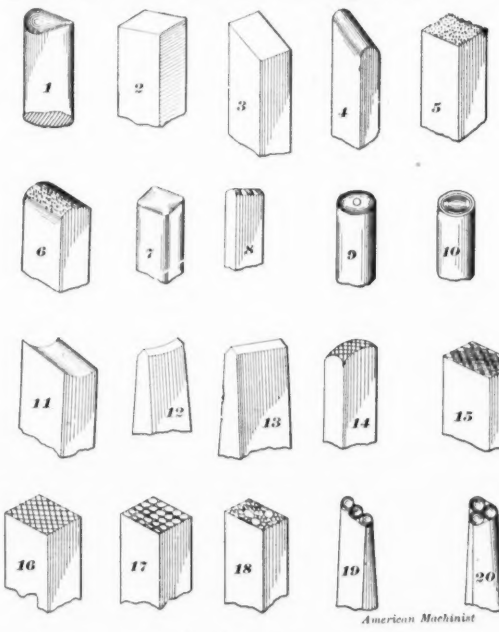


Fig. 21

No. 3. Side planisher. For finishing the flanged, or other edges of recessed, or relief work, such as shown at $b\ b'\ b''$ (Figs. 22 and 23).

No. 4. Half round planisher. For finishing the inside of grooves, along fillets, etc., such as $a\ a'$ (Figs. 24 and 25).

No. 5. Flat planisher. For producing a slightly matted surface on work, such as shown at $c\ c'$ (Fig. 23.)

No. 6 Half round (convex or male) planisher. For producing a slightly matted surface or grooved and other work.

No. 7. Plain planisher with edges slightly rounded off.

No. 8. Half round cross grooved tracer. For making and finishing borders on ornate work.

Nos. 9 and 10. Male and female beading tools. For finishing the beads and cup-like depressions on ornate work.

No. 11. Half round (concaved) tracer. For finishing half round or round borders and similar work, such as $b\ b'$ (Figs. 24 and 25).

No. 12. Plain semi-circular tracer. For finishing along the flanges or corners of round and other curved work, such as $c\ c'$ (Figs. 24 and 25).

No. 13. Plain tracer. For finishing along the corners, and elsewhere of plain work.

Nos. 14 to 18. Matting tools. For producing heavier or deeper matted surfaces, one form of which is shown at c (Fig. 25) $d'\ d''$.

Nos. 19 and 20. Other forms of beading tools. Any and all of the above chasing tools are made male or female, as required, to produce an embossed or indented matted or other appearance.

When the work to be chased is flat and has no recesses on the under or opposite side of it, and the form is such that it cannot be held in the vise while being chased, the work is held on a plate of cast or wrought-iron with common solder. The plate may be from $\frac{1}{2}$ inch to 1 inch in thickness, and of such size otherwise as to admit of one or more pieces of the work to be chased being soldered on the top of it. On the under side of the plate are lugs or projections, by which it is held in the vise. The top of the plate should first receive a coating of common solder, and while the plate is still hot enough for the solder to flow, the work is (after being straightened on the opposite or under side by means of a wooden or raw hide mallet) laid on the plate to which it will adhere, and then cooled off. After the work has been operated on, the plate is again heated, and the work taken off.

In other cases where the inner or under side of the work is of such shape that it cannot be soldered on to the above mentioned plate, or held in the vise, it is sometimes held by means of a leather strap on a block of wood cut out to fit the work, or on a sand bag. The work being placed on the block or bag, and held by the strap, applying the pressure (to hold it down) with the foot.

When the form or shape of the work is such that it cannot be held while being chased or operated on, by any of the above methods, as in the case of the pattern, Figs. 22, 23, 24 and 25, where the inner or under sides of the patterns are recessed, the work (with the exception of the surface to be operated on) is imbeded in a block of composition, made of resin of ordinary grade, and plaster of paris, equal parts, to which is added (about one ounce to the pound of composition) tallow (candles). The whole being mixed together by heating in an iron pan or kettle. The resin being melted first, then the plaster of paris being gradually stirred in with the melted resin, after which the tallow is added, and the mass poured out to form a block of suitable size, and allowed to cool. To imbed the work, the top surface of the block is again softened by heating it with a Bunsen burner or blow pipe. The heated surface is then pressed or kneaded to such shape as will approximately conform to the recesses and shape of the work. The work is then pressed down, as far as required, into the composition which is then squeezed well up to the work all around, and allowed to cool.

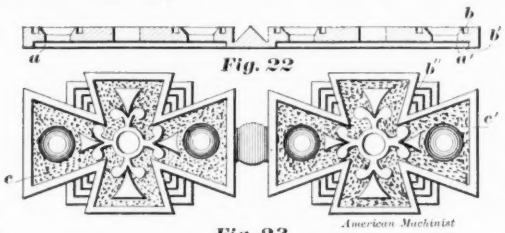


Fig. 22

Fig. 23

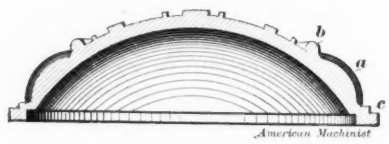


Fig. 24

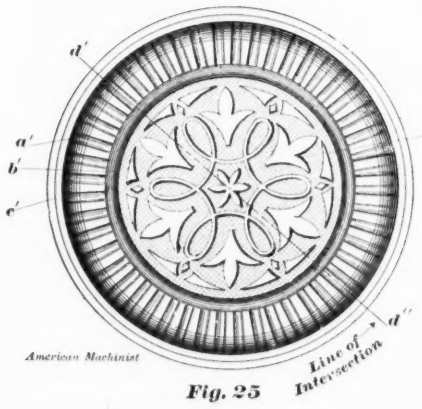


Fig. 25

CHASING.

The work is finished by hammering the surfaces down with the punches and hammer, in such a manner as to leave them perfectly smooth, or to transfer the design (if any) on the punch to the surface of the work. Of course, it will be understood that the action of the hammer and punches on such work as Figs. 22 and 23, will be analogous to that of peening, and therefore has a tendency to warp or change the shape of the work, but as the work is always made of bronze, composition, or other soft or malleable metal, it can be readily straightened and restored to shape with a wooden or rawhide mallet.

$d'\ d''$, Fig. 25, shows line of intersection for Fig. 24.

Compressed Air—Electric Traction.

The Mekarski system of tram traction by means of compressed air has been adopted on three lines operated by the General Omnibus Company of Paris. The lines in question are amongst the most important of the whole Paris system. The longest is that from the Louvre to Sèvres and Versailles, a distance of about 12 miles. The two other lines are those from the Louvre to St. Cloud, and from the Cours de Vincennes to St. Augustin, distances of 6.3 and 5.7 miles, respectively. The first two of these lines will be worked as one system. Trains of three cars, seating 51 persons each, and drawn by a compressed-air locomotive, will start from the Louvre every quarter of an hour. These trains will be broken up at the junction of the St. Cloud and Versailles lines, one car going on to St. Cloud, and the other two to Sèvres and Versailles. The locomotives to be used will be supported on six wheels, all coupled. They will weigh 18 tons each, considerable adhesion being required to mount the incline of 1 in 23, which occurs on the Sèvres line, when towing three cars, each of which, in the loaded condition, weighs 8 tons. Twenty-three of these locomotives are to be built, of which six will be kept in reserve. The air pressure to be carried in the reservoirs will be 1,138 pounds per square inch, and a sufficient quantity of air will be carried to enable the locomotives to run 12 miles without recharging.

Electric traction by means of accumulators has been for some time employed by the Northern Tramways Company of Paris. The cars on this line are arranged to seat 52 persons, and inside this city run at a speed of 7½ miles an hour, which outside the barriers is increased to 10 miles an hour. Inclines of 1 in 25 have to be mounted at certain parts of the line, and each car runs about 80 miles a day.

The motive power is supplied by a battery of 108 cells, having 11 plates each. These cells are fitted inside 12 cases. They are coupled into four groups of 27 cells each, so that the electro-motive force of each group is about 50 volts, and these groups can at will be arranged either in series or parallel, so that a wide range of potential is at the service of the driver. The two motors, moreover, which drive the car axles, can also be coupled at will in series or parallel, and thus at need a large reserve of power is available for climbing grades, etc.

The total weight of the car with accumulators and passengers on board is 12 tons, which would make the weight of motors and accumulators about 4 tons. Readings taken on a complete run showed that the average tractive effort was about 15½ pounds to 17 pounds per ton, but the maximum was 80 pounds per ton. The cost is said to work out to .85d. per mile, or almost the same as horse-power on the same lines.—*Engineering.*

On the Cultivation of the Inventive Capacity by the Solution of Constructive Problems.

BY LEICESTER ALLEN.

I have taken time to examine the solutions of Problem No. 6, and herewith present two of those which have been sent in. I take this opportunity to state that I am in position to know the secret of the hidden movement which was inaccessible to Mr. Miller when he examined the German lathe at the Chicago Exposition, from the action of which this problem was suggested. I will say that, so far, none of the solutions sent in, although they effect the desired result, do this by mechanism quite identical with that on the German lathe referred to. I shall say more on this point hereafter.

I have to thank Mr. J. T. Slocomb, of Providence, R. I., not only for the interest added to this series of articles by his excellent solutions of all the problems that have been presented, but also for an excellent solution of Problem No. 6, which I herewith take pleasure in presenting in Fig. 1. As I anticipated, fewer solutions to this problem have been sent in than have been received for the simpler one of the ratchet movement.

In Fig. 1 *B* represents the drive from the lead screw, *A* the drive from the back shaft, and *C* the splined shaft, inside the bed of the lathe. The shaft *C* carries the worm wheel *D*, as shown, the latter coupling the shaft *C* to the shaft *A*, so that when the worm does not turn on its own axis the two shafts must move at the same rate of speed, and in the same direction. The end of the shaft *A* adjacent to the worm wheel is enlarged, and on one side has a forked head that carries the worm *E* and its spindle. When the worm *E* does not revolve on the axis of its short spindle the worm wheel *D* does not revolve on its axis, but both these parts revolve about the axis of the shaft *A*. It also will be seen that if, while this revolution is taking place, the worm *E* be caused to rotate in either direction on its axis it will retard or accelerate the rotation of the shaft *C* according to the direction in which the worm rotates. To fulfill the conditions of the problem completely it becomes necessary that the shaft *C* be accelerated or retarded, according as right or left-handed spiral teeth have to be backed off, or that it may rotate at the same speed as the shaft *A* rotates, in order to back off teeth of cutters which are parallel to the axes of the cutters. By very simple means Mr. Slocomb achieves either of these three modes of action: *F* and *G* are two spur gears fastened together, but free to be revolved upon the shaft *A* by the pinion on the inner end of the shaft *B*. A bevel gear *H* is mounted upon one end of the worm spindle and drives the worm as hereafter described. The bevel gear is indicated in dotted outline. In dotted outline also are represented bevel pinions *K K'* in mesh with the bevel wheel *H*. These bevel pinions are to be provided with clutch connections, not shown in the sketch, by which either may be engaged with or disengaged from the shaft *L* which carries the pinions, which shaft is driven by a spur gear *M*, shown in dotted outline. It is to be understood that this mechanism is all carried by the forked head of the enlarged part of the shaft *A*, above spoken of, but not shown in the figure. The spur gear *M* engages or is engaged by the spur gear *G*. Now, if the gear *G* be held stationary, the worm *E* will be driven quite rapidly when the shaft *A* is put in motion; but, if the gear *G* be also revolved in the same direction at a little slower rate, the worm *E* will get very little motion. Also it will be evident that if the gear *G* be revolved in the opposite direction a contrary effect will be produced. The motion is reversed by the use of the bevel pinions and their clutches so that either right or left spirals may be backed off; or by leaving both clutches disengaged, cutters having teeth parallel to the axis of rotation may be backed off. The variation of speed of the shaft *B* can be effected by change wheels as desired.

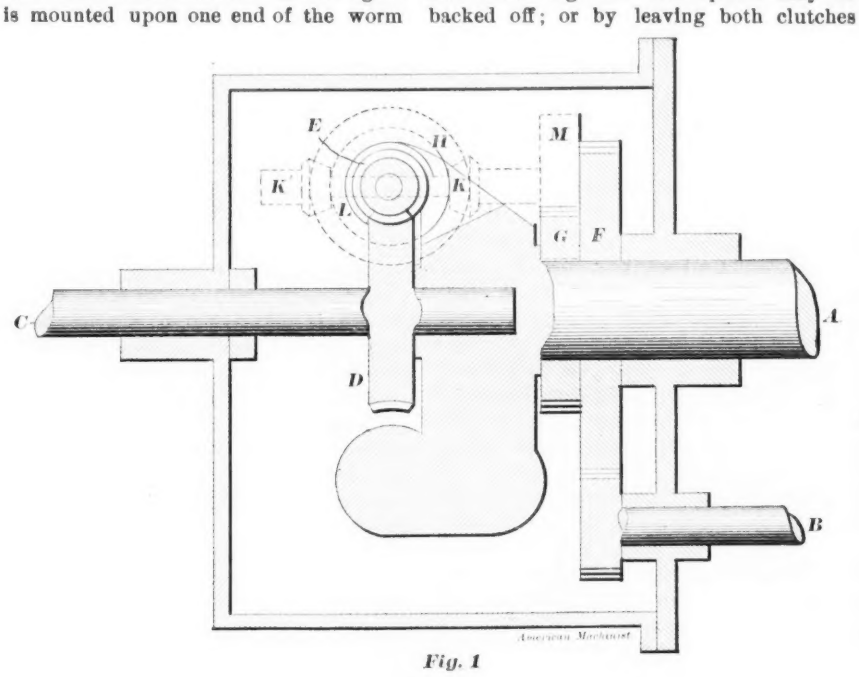


Fig. 1

Mr. Albert D. Colburn, of New Haven, Conn., who has also contributed largely to the general interest taken in these problems has sent in a solution to Problem No. 6, which is illustrated in Figs. 2 and 3. In his letter accompanying the sketches Mr. Colburn gives the following explanation:

"The requirement is that the proper spiral given to the cutter shall be conformed to by the backing off tool, in this case supposed to be one revolution of the spiral in 36 inches in length of the cutter, or in the travel of the carriage. In the solution I have assumed the cutter to have 10 teeth, the lead screw to have five threads to the inch, the cut to be $\frac{1}{100}$ inch, so that there will be 100 revolutions of the cutter or lathe spindle to each inch of travel of the carriage. If the cutter has 10 teeth, as assumed, the cam at the end of the vertical shaft in the carriage must make 10 revolutions to each revolution of the spindle or cutter to be backed off. This, of course, is done by the proper change gears at the head and at the back of the lathe, giving the back shaft the same number of revolutions as is required by the vertical cam shaft, which motion is transferred through the equal spur gears at the foot of the lathe to the short shaft *g* on the inner end of which is a bevel gear *a*, that, acting through the idle gear *b*, gives motion to the bevel gear *c* keyed to the end of the splined shaft which transmits motion to the bevel gears that operate the cam, giving to the latter the number of revolutions required. The number of teeth in the bevel gears *a*, *b* and *c* is indefinite; it being only required that *a* and *c* shall each have the same number.

"Mr. Miller says, in this case, the cam will need to be 'retarded' in its movement as many revolutions as there are teeth in the cutter during 36 inches travel of the carriage. This may be admitted, but I will not look at it from that standpoint in this case. If it be required that one revolution of the spiral shall be made during 36 inches travel of the carriage, then $\frac{1}{36}$ of a revolution will be made in 1 inch of the travel, or $\frac{1}{3600}$ revolution in $\frac{1}{100}$ inch the travel, or one revolution of the cutter. Suppose we place a barrel covered with paper after the manner of the barrel of a steam engine indicator, 36 inches long, between the centers of the lathe, and cause it to revolve with the spindle. Also suppose a lead pencil to be so placed on the carriage that its point can be pressed against the barrel. Suppose also a cam to be on the splined shaft running through the center of the lathe, or, as we already have a cam on the vertical shaft, we can use that, against which the butt end of the lead pencil may be placed. Suppose

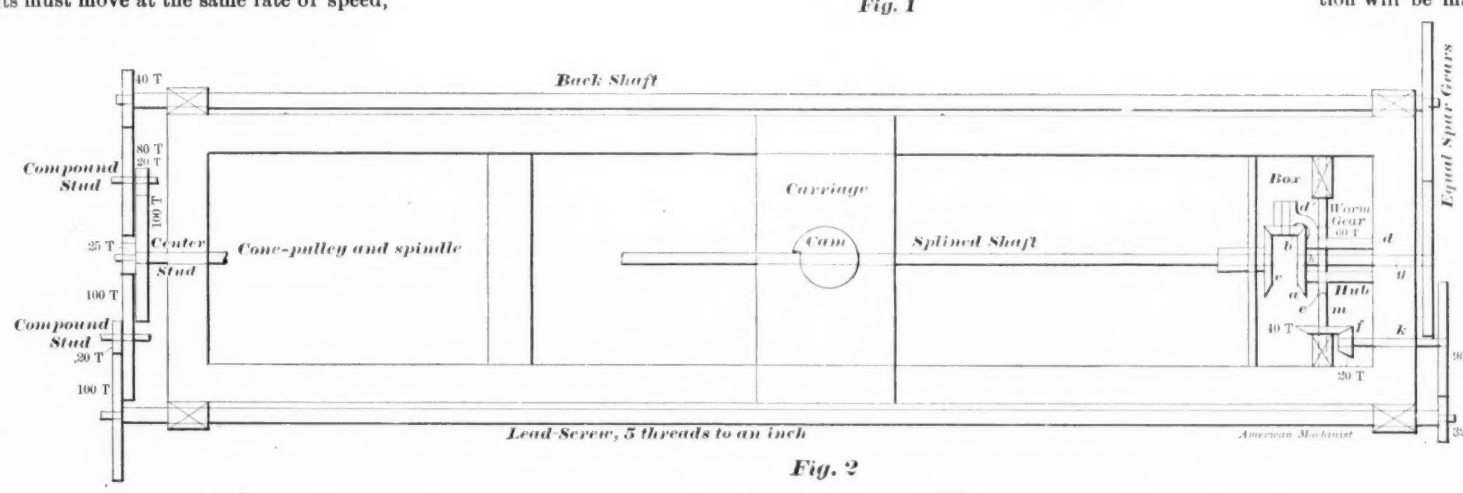


Fig. 2

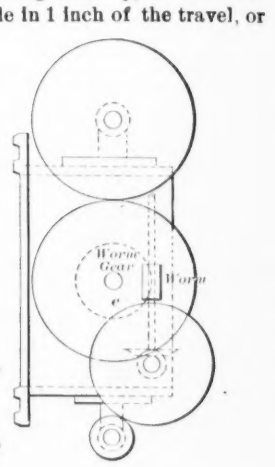


Fig. 3

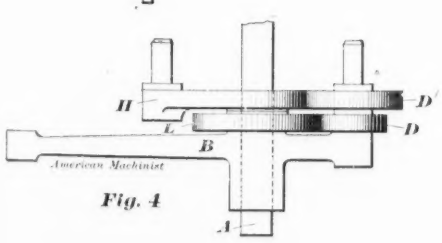


Fig. 4

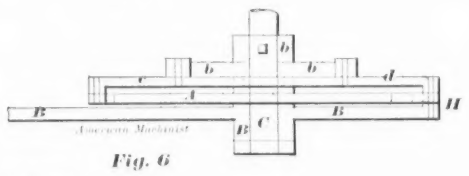


Fig. 6

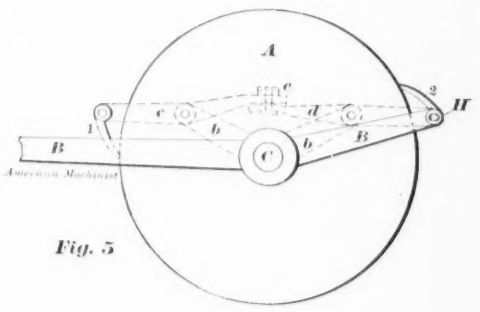


Fig. 5

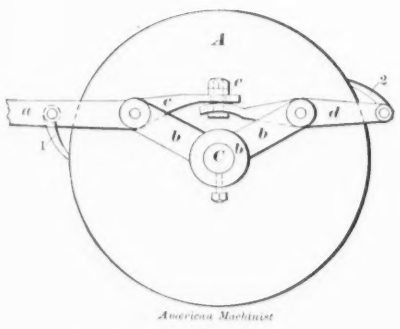


Fig. 7

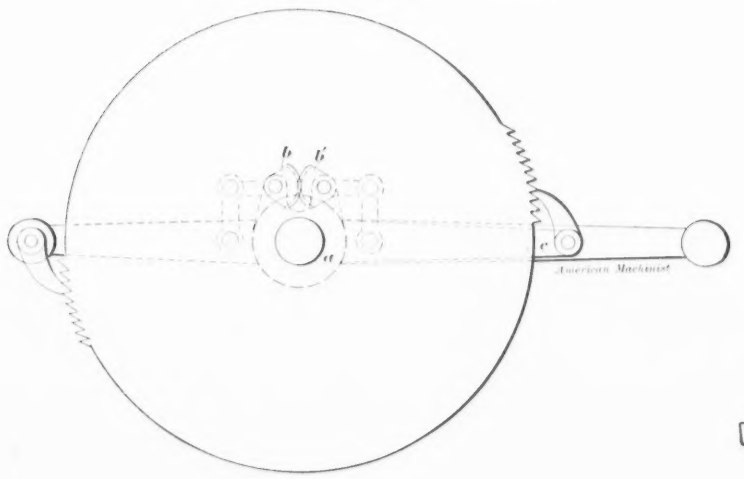


Fig. 8

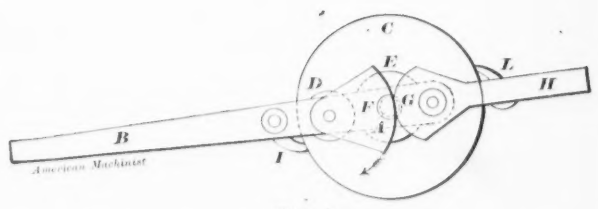


Fig. 9

now that we make a point with the lead pencil on the paper, and then turn the spindle one revolution; the cam then makes another point at a distance $\frac{1}{100}$ inch lengthwise of the spindle from the first point, as the carriage has moved $\frac{1}{100}$ inch while the spindle has made one revolution; but the cam makes 10 revolutions to 1 of the spindle so the pencil has made 10 points around the barrel. The first point and the last point so made are $\frac{1}{100}$ inch apart lengthwise of the cutter; they should also be $\frac{1}{3600}$ of a revolution apart, either retarded or advanced according as a right or left hand spiral is to be operated upon. Mr. Miller says 'retarded,' and we will call it so. Therefore, in 3,600 revolutions of the spindle the pencil or the tool will have lost one revolution of the barrel, making but 3,599 circuits of points on the barrel during the 36 inches travel of the carriage. To do this it will require that the splined shaft shall be retarded one revolution out of the number which the change gears at the head of the lathe would otherwise give it for every 3,600 revolutions of the spindle. Inspecting the drawing and figuring the feed-screw change gears at the head of the lathe, we find that while the spindle makes 3,600 revolutions, the screw makes 180 revolutions. Figuring the change gears at the foot of the lathe we find that the worm shaft m makes 30 revolutions. The worm gear having 60 teeth makes but $\frac{1}{2}$ of a revolution. This worm gear is attached to a hub d which has an arm carrying the shaft d' upon which the idler gear b is keyed. The hub d is free to revolve on the outside of the bearing h of the shaft g when actuated to do so, and if the bevel gear a is stationary, and the hub d and gear b are revolved $\frac{1}{2}$ a revolution the gear c will make one revolution. But it makes no difference whether the gears a, b and c are revolving or stationary, a half-revolution of the hub d will cause the splined shaft to lose or gain one revolution in the time it takes for the hub d to make its half revolution, regardless of how many revolutions the splined shaft may be making in the same time. It will therefore be seen that by the proper change gears at the foot of the lead screw almost any spiral can be given to the cutter; also that by the proper change gears at the head end of the back shaft any number of teeth may be cut or backed off. The revolving of the hub d could be accomplished by spur gears to replace the 20 and 40 tooth bevels, and the worm and gear; but this would require more gears and shafts and take up more room. Also the worm and gear make a good stop for the hub d when the change gears at the foot of the lead screw are disconnected while backing off radial or straight-faced cutters."

A comparison of this solution with that given by Mr. Slocomb will show that there exists no substantial difference in principle between them. I have, however, thought it best to give Mr. Colburn's solution because the line of reasoning pursued by this gentleman will be very useful and instructive to many young men who are interested in these solutions.

I am in receipt of letters from several correspondents calling my attention to an error in the solution to Problem No. 7, contributed by Mr. Herman Oberg, printed in the issue of July 26th and illustrated in Figs. 9 and 10 of my article published in that issue. As these communications are substantially of the same tenor I will content myself by printing only one of them—the first one received—from Mr. Walter Gribben, of Brooklyn, N. Y. Mr. Gribben writes:

"If I have correctly interpreted the construction of Mr. Oberg's device (Figs. 9 and 10, issue of July 26th), I do not think it would operate according to the conditions of the problem. His segmental gear H and the gear L that is keyed to the shaft must both be of the same radius in order that both may mesh with the wide pinion D. This being the case, it looks to me as though the rock lever H would always remain at rest, just as though it were fastened to the gear L. The device would operate, however, if D were made narrow and of half the number of teeth of L, as per sketch herewith (Fig. 4), D having another gear D' fastened to it, and of the same radius as the segmental gear H. Or, if preferred, L and D might be equal gears, and H half the radius of D'. Either way would accomplish the same result."

I confess to having overlooked the defect in Mr. Oberg's solution, thus pointed out, and am obliged to Mr. Gribben and others for calling my attention to it.

Figs. 5, 6 and 7 illustrate a solution of Problem No. 7, contributed by Mr. Colburn, in addition to his solution of Problem 6 given above.

In Fig. 5, B is a casting with two arms, whose central hub is fastened to the shaft or fixed spindle C. To the outer ends of the arms are journaled the levers c and d by pins on which they swing or rock. The inner ends of c and d are held together by a bolt with a spring or bit of rubber e under the nut, which allows them to move freely up and down without any lost motion. At the right hand end of d and B a pin passes through, connecting d and B, and also holding the pawl 2. When the long end of lever B is pressed down the pawl 2 engages the ratchet wheel, causing it to revolve. When the same end of lever B is raised, the other end goes down, depressing the outer end of lever d and elevating the inner ends of the levers c and d. At the same time the outer end of the lever c is moved downward, causing pawl 1 to engage the ratchet wheel, revolving the latter in the same direction as before.

With reference to this solution Mr. Colburn adds the following: "It will be noticed that the lever c rests on the top of the lever d at the inner end, and that the bolt passing through them both has nothing to do but to return the pawl 1 to its starting place. I would much prefer to modify the arrangement and dispense with the lever B, adding a long end to the lever c as shown at a in Fig. 7, wherein the operation of the two levers and the two pawls will, I think, be readily understood by a glance at the drawing."

A very neat solution of Problem No. 7 is given in Fig. 8. It is the contribution of Mr. R. B. Cochrane, of Valparaiso, Ind. A collar a is fastened to the shaft, having two lugs, which give a bearing to the segmental gears b and b', which are connected by links to the rock lever and the arm c. The action of this movement is so obvious that it needs no further exposition. The device is mechanical in every way, and fulfills all the conditions of the problem as given out.

In Fig. 9 is shown another solution of Problem No. 7, which is the contribution of Mr. D. B. Getty, of Cedar Rapids, Iowa. To the shaft or stationary spindle A is securely fastened the toothed gear E. This gear is near enough to the end of the spindle to permit the lever B to pass between it and the disk wheel, the gear coming flush with the end of the spindle. Through the long arm of the lever passes a stud which revolves freely, carrying the pinion D on one end, and the segmental gear on the other, both being fastened to the stud, and turning with it. Now, if the long arm of the lever B is moved upward, the pinion D will be actuated by the wheel E to move the arc F in the direction of the arrow, which, in turn, moves the segment G in such a way as to cause the arm H, provided with the pawl L, to revolve the ratchet wheel C in the direction required. The pivot of the pawl L is, of course, not fastened rigidly to the part H, but is carried by a movable slide and spring mechanism, so as to accommodate itself to the arc of the circumference of C, the arm H having such a radius between the center of the stud and the operating point of the pawl as to turn the disk through the same arc as that through which the pawl I will turn it, although the latter acts on a radius equal to that of the pitch line of the ratchet. Mr. Getty has not figured out the proper length of the radius of the arm H to accomplish the desired result, and by this omission the solution has been left incomplete. I think the arrangement can be made to operate as desired by a proper proportioning and adjustment of parts, and I regret that Mr. Getty did not thus carry out this scheme to a logical conclusion.

LETTERS FROM PRACTICAL MEN.

Peening and Straightening by Heat.

Editor American Machinist:

The remarks of Mr. J. T. Usher, in your issue of August 16th, have called up some past experience in straightening or changing the shape of metal by peening. First, a word about hammers. In the AMERICAN MACHINIST of May 31st some very neat designs of flat-peened hammers appeared. They attracted my attention because this kind of a hammer is now so seldom seen; the round peen seems to be all the go, and yet for peening purposes they are of little use unless it is for knocking down the ends of rivets.

As for straight and cross peen hammers the latter is undoubtedly the most useful of the two, though for appearance sake the unwary machinist would be most likely to choose the straight peen. The reason I speak of this is because of the difficulty in directing a blow accurately with the peen standing lengthwise of the handle. All machinists will have observed that lateral vibrations of the hammer are harder to control than those in line with the arm or hammer handle.

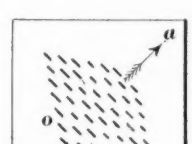


Fig. 1

Fig. 2

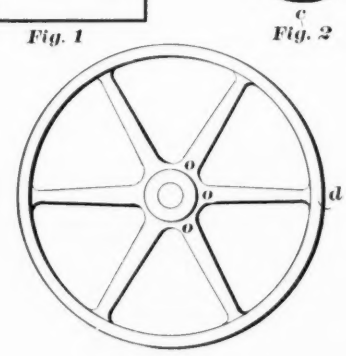


Fig. 3

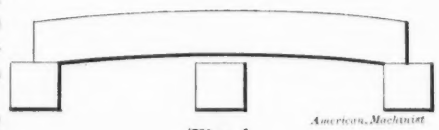


Fig. 4

PEENING AND STRAIGHTENING BY HEAT.

Another quality found in a flat peened hammer, over the round peen, is that in straightening a plate, for example, the round peen expands the metal in every way alike, a thing not at all desirable sometimes.

Let Fig. 1 represent a square plate, the two corners at a a' are sprung upward. This may be readily straightened by a few strokes of a hammer of the proper form. It is clear that in this case the stretching of the metal should be but in one direction, that of the arrow, but this could not be done with a round peen. Of course, the strokes must be applied so as to make impressions transverse to the arrow as indicated by the marks at o. If the peen of the hammer be slightly rounded, as shown at c, Fig. 2, the work will be much smoother than when the corners at d d are allowed to leave their impression.

Whatever may be said about peening not being a good practice, it is often very convenient to resort to it, and I think the changed shape given in this way is much more enduring than is sometimes supposed. I have seen some severe tests made of this on portable steam engines, the pulleys on which had unusually heavy rims; they were 42 inches in diameter and had six arms oval in cross-section. By improper clamping of these pulleys in the lathe the arms would be so sprung that when finished and keyed on the engine shafts the rim would sometimes run out or vibrate sidewise, an eighth of an inch or more. I found a few strokes with a peening hammer would correct this perfectly. This was done by chalking the rim when in motion, say, at d, Fig. 3. Then with a sledge held against the arms near the hub the peening was done on the opposite side and so distributed as to bring the strain as equally as possible on, say, the three arms o, o, o. By a few trials these wheels could be made to run true. These engines were speeded to 150 and 175 revolutions per minute, and being mounted on wheels were often quite unsteady, especially when the fly wheels were not perfectly balanced. All this, together with the unequal strains produced by the engine, might be supposed to interfere with the permanence of the peening and gradually allow the pulley to resume its wabbling condition; but in no instance did this ever occur so far as I know. A shaft peened in this way will, of course, spring back after being turned and must be re peened. When cast-iron shafts were often used this was the only course, unless heating was resorted to. When this was done a plan was employed which may be new to some of your readers. It was as follows: The shaft, bed-plate, or whatever it might be, was placed on the ground, with a support under each end so as to hold it a foot from the ground, and with the rounding side up. At the point where the crook was greatest another support was placed so as not to touch the casting, but in exact line with the two outer supports.

Fig. 4 will illustrate the arrangement. At the point where the bending was to take place a brisk fire of wood, or coal, was kindled and kept burning until the article became sufficiently heated to yield by its own weight and drop to the center support. There was nothing further to be done except to let the casting cool gradually. If, however, the heat was not sufficient to cause a permanent change in the structure of the metal, it would, when cool, assume its original shape.

At another time I may undertake to show how I straightened some steel plates. They were one inch thick and eight feet in diameter. In a plate-mill or shipyard this might have been easy enough, but it was certainly a job not suited to a small machine shop.

"QUIRK."

Thawing Frozen Hydrants—Bursted Water Mains—Taking Risks.

Editor American Machinist:

Regarding some of the problems stated by "Troy," in the AMERICAN MACHINIST of August 23d, and in your editorial of the same date, permit me to suggest possible solutions. But first, I do not wish to go on record as advocating either the electrically driven or the compressed air fire engine. "Abolish the fire engine entirely," is my claim, and let a high pressure water service take its place, as stated in the issue of August 2d.

"Troy" says: "A fire engine which could not quickly supply steam to thaw out frozen hydrants would lack one of its most important features." In the next paragraph but one he says: "In fire service no risks must be taken that can be avoided." There is an answer to the first quotation. Why let the hydrants freeze up? There is no need of it. A hydrant never freezes if properly located, erected and taken care of.

Who ever heard of a hydrant supply pipe freezing when buried 4 feet deep in the latitude of New York, 6 feet deep at Boston, or 8 feet deep at Portland? Yet hydrants *do* freeze in each city mentioned! Why? Because they were not properly located. Somebody "took a risk" and furnished defective fire apparatus to the city or town.

As "Troy" says, hydrants do freeze, and must be thawed out; but is it necessary to have a steam boiler at hand and do the business with steam? I guess not. Just keep a 5-gallon can of naphtha on the hose wagon or truck. Then, when a frozen

hydrant is met with, douse on a pint or so of the "liquid gunpowder" and touch it off. No need of shavings to light that stuff with, and it will go to the botton of a hydrant pit and take a hot blue flame with it.

In testing steam boilers, new ones especially, by hydrostatic pressure in very cold weather, before the boilers have been set, the water is nearly to the freezing point, the boiler quite so, and the little "weep holes" and small leaks quickly fill with water and freeze, becoming so water tight that they cannot be discovered even when the boiler is under all the pressure allowed for testing. In such cases, a dash of naphtha ignited on the outside of the boiler quickly thaws out the shell.

In regard to bursted water mains, the treatment is the same as for frozen hydrants, viz., don't put in pipe that can burst. In hydraulic mining they have little trouble in piping water in large mains under 500, 600, or even 1,000 pounds pressure per square inch. But if somebody will *take risks* and put in doubtful piping, then cut-off valves must be furnished liberally enough to enable any ruptured main to be promptly cut out.

JAMES F. HOBART.

Can We Run 100 Miles Per Hour?

Editor American Machinist:

While in conversation with a practical railroad man the above question came up for discussion and the subject was argued pro and con; I think it was in *Scribner's Magazine* an article appeared some months ago showing the impossibility of 100 miles per hour ever being accomplished. Now, this is an age of record breaking; almost every day we notice accounts of steamships, yachts, bicycles, railroad trains, and even homing pigeons, breaking the records of former achievements. The railroad man above mentioned handed me a list of figures of the size of a locomotive that he thinks will make the 100 miles, or, in other words, will have the power, providing the road-bed will stand the strain. They are as follows:

Boiler, 60 inches diameter, short smoke box.

Tubes, 448 — 1½ inches diameter, 13 feet long.

Steam pressure, 200 pounds.

Cylinders, 21 inches by 22 inches.

Diameter of drivers, 84 inches.

Grate surface, 84 feet, 10x8½, which he figures out as follows:

Heating surface in tubes, 2,287 feet.

Heating surface in fire-box, 205 feet.

Total heating surface, 2,492 square feet.

(I give the figures as handed to me.)

Revolutions per mile, 240.

This engine would have 5½ feet heating surface to 1 square inch of cylinder; the ordinary Reading engines have but 3 feet to 1 inch of cylinder, or 1,132 feet more heating surface than the Reading engines. This engine ought to have about a seven (7)-inch nozzle.

Of course, there are many things that must be taken into account on both engine, train and road to keep up a speed like this. Some say the steam cannot travel fast enough to move the pistons without losing much of its power, the 8 foot or 9-foot wheel will remedy this.

I remember when a boy working on a locomotive that had 10 foot 6 inch drivers, and that nearly 50 years ago I rode on that same engine 84 miles per hour. It was built at the Railway Foundry at Leeds, Eng., designed by Mr. James Fenton. It had inside cylinders and only two pair of drivers, no truck wheels, and on that account was afterwards condemned by the Government Inspector of Railroads. The wheels were wrought-iron. The large fire-box (Wooten) with the combustion chamber left out, and the tubes run the full length of barrel, increasing the heating surface. The large nozzle is very necessary to take off all back pressure. I believe in large nozzles, they tell very favorably on the coal bill. I remember 10 years ago a new Wooten engine came to the road which I had then charge of; cylinder 18 inches by 24 inches, 61-inch wheel, the nozzle was 4⅞ inches with plug in center to vary the exhaust. After running the engines a few days we found it necessary to tie open both fire doors to keep the steam down, so we commenced opening the nozzles, took out the plug, and bored out and bored out until there was no more to bore, and when I left the road there was a six and five eighths (6⅝) inch nozzle in that engine. Mr. Angus Sinclair said it was the largest nozzle in the United States.

I remember an engine built in 1853 on the same road; we were trying to reduce the coal bill, and my theory was if I could reduce the back pressure in cylinders, the engine would run more free, but opening the nozzle reduced the draft, so to remedy this, as I could not make the fire-box larger, I made the smoke stack 2 inches less in diameter, and this had the desired effect. It steamed so well after this change that I took out the nozzles altogether and found that the exhaust passages were too small, as she still made more steam than we needed. In those old times our extension front was on top in the shape of a bell stack, which we emptied with a stick of wood and a piece of rubber hose on it, and when the extension front excitement came up I did not fall in love with the theory; I thought the improvement was on the wrong end of the engine, for I believed the sparks should stay in the fire-box and be burned, and if the fire-box could be enlarged, draft reduced, the fuel would be more thoroughly consumed and money saved; so we hailed the Wooten fire-box as a step in the right direction. Higher pressure is another advantage. Some persons thought me a crank ten years ago when I said boilers would be built to carry 200 pounds pressure. I guess we will get there.

It will be necessary to enlarge engine truck and tender wheels, journals also. Every advantage must be taken to avoid the pressure of the atmosphere on exposed parts of engine and train. I expect to see the headlight glass cone shaped and smoke box front also; cab front doors open at an angle instead of square with the side of the cab; baggage car ends pointed, and other small matters attended to. We will get the 100 miles per hour and wonder why we were so slow before.

Hanover, Pa. JNO. J BINGLEY.

Scarecrows of the Would-be Mechanic.

Editor American Machinist:

I believe it takes something of a hero these days to be a mechanic—that is a good, honest, contented, self-respecting mechanic. It at least requires a more or less lively exercise of some of the heroic virtues in the beginning.

Boys of the present starting out to learn the machinist trade, outside of a technical school at least, are liable, in most cases, to have a pretty hard "row to hoe," and a good many of them drop their hoes before going very far, and the remainder of their rows grow up with weeds, and they themselves wander about in life from one thing to another, doing a little of everything and nothing well—the scarecrows of Grease, Discouragement, Society, Fashion, etc., having frightened them off the only field in which by nature they were fitted to succeed. These scarecrows, of course, seldom *all* loom up before the vision of a single boy. One boy may revel in grease, and not care particularly what his "dude" friends say of his clothes, but may be easily disheartened, and, perhaps, a little lazy, and so discouragement gets hold of him. Another may have a good share of pluck and perseverance, but be mortally sensitive in the matter of dress and social standing, so that giving up his trade and going at something else seems small in comparison with the lowered regard, real or imaginary, of his companions and of society at large. In either case the boy may have some mechanical ability, but the pressure of outside forces proves too great.

I have no doubt but that nearly every machinist has at some period of his life been beset by the scarecrow of discouragement, and while it appears, I presume, to everybody in general, it seems to take peculiar delight in frightening the machinist. It is about the first one to appear to the young machinist after having vanquished Grease, and having once fully decided to learn the trade. It comes when after having worked a while he sees that nobody seems to take any interest in him. The foreman or boss never tells him how to do anything, and yet expects him always to do things right. The other boys in the shop tease and torment him, perhaps, especially if he be religiously inclined, and is manly enough to cherish and obey the teachings of a good mother on moral lines. And if, perchance, the filth and foulness, which go to make up the daily conversation of so many workmen, fill his soul with loathing and his face with shame, and their sneers at his innocence and "greenness" sometimes cause him to choke and feel like crying and fighting at the same time—then, indeed, is his lot a hard one, and his enemy, the scarecrow, aided by those who should be his friends.

In this respect, I think, that foremen and the older shop hands are in some degree responsible for the failures of young mechanics. Not only failure as regards a mechanical pursuit but failure in any occupation which against his will and inclinations the boy is forced to take up. I call to mind now the case of a young doctor who, a year or so ago, used to haunt the shop where I worked like a troubled spirit. He may not have been hindered from following a mechanical pursuit by any of these things of which I write; I never got acquainted with his early life and therefore do not know, but one thing I do know, he has had but poor success at doctoring, and whether or not these things are to blame for his failure his case is a good illustration of what I wish to bring out. He used to talk—ask questions mostly—by the hour about tempering, forging the different kinds of tool steel, the way to grind and set a lathe tool, the relative wear and usefulness of different metals, etc., seeming to take a most keen delight in acquiring knowledge of this sort. He even went so far as to arrange a shop in the basement of the house where he roomed in which he would toil away sometimes far into the night. I cannot but think that some of these scarecrows must have got after him in his youth—he is now a man of 30—in the shape of some of his relatives, perhaps, and scared him from the one pursuit in life for which nature has so obviously fitted him.

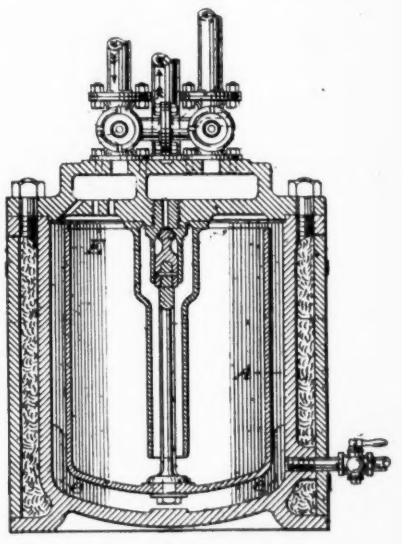
However, there are other scarecrows besides that of Discouragement, and chief among these is the one known as Public Opinion, Custom, Fashion, Social Influence, anything you like, any one of these or all of these put together. It is that undefinable something in society which tends to make people look down upon or regard as inferior those of their fellow-beings who, through choice or otherwise, earn their living by grimy manual labor, and not by selling ribbon, or keeping books, or running a typewriter. And what is, if possible, worse, it also tends to create a feeling of shame and false pride in the laborer by which he is made to imagine his situation a great deal more humiliating than it really is. The very civilization which has been largely brought about by the great *mechanical* improvements of the last 50 years has taught the workman in these later days to be ashamed of a *mechanical* pursuit. This seems passing strange, yet in many instances it is true.

For the solution of part of this perverted Public Opinion I think we have the factor Prejudice. In Shakespeare's time an artisan or mechanic was regarded as the lowest type almost of ignorance and boorishness, and I guess in many cases they were justly regarded so, but times have changed since then, and anybody now who does not know that it takes just as many brains to be a good mechanic or engineer as it does to be a good doctor or lawyer is very much prejudiced, indeed, if not something worse. Yet it seems that some people are still swayed by these old prejudices of two or three hundred years ago, and do not realize that the major part of all the luxuries and conveniences they enjoy are the gifts, through the advent of steam, labor-saving machinery, etc., of these same greasy and boorish mechanics.

If this were the only side to this scarecrow—that is, if its influence could only be brought to bear on the young mechanic from the standpoint of the outside world looking down on him—it would not be so bad, *but it finds an echo of consent in his own heart*, which makes it of all scarecrows the mightiest of the mighty.

It may be that I exaggerate the situation or that I take the whole thing too seriously; yet I believe there are those who, with me, will think it deplorable that a young man in the evening of the nineteenth century should be *ashamed* of an occupation like that of machinist, in which there is such ample room for the exercise of brains as well as muscle, simply because it requires him to wear overalls and get his hands black.

ANTI-KNOW ALL.



Marine Water Trap.

We present with this a sectional view of a water trap designed especially for use in steamships, being a modification, for marine purposes, of a trap formerly made by the same inventor, Mr. John McKellar, of San Francisco. In the present form of trap all the working parts are attached to the cover, so that they are very readily gotten at for inspection or repairs; steam can be blown through all of its parts, and it is covered with non-conducting material and lagging to prevent radiation of heat.

In operation, the normal position of the parts previous to a discharge is as shown in the engraving. Water enters the left-hand pipe as indicated by the arrow, and passing through the perforations seen in the bottom of the left-hand chamber of the cover, fills the space outside the floating vessel *E*, and holds it up, thus keeping the valve up to its seat, as indicated. But when the vessel *E* is also nearly filled with water it sinks and opens the valve; the contained water being then forced out through the bottom of the sleeve which surrounds the valve stem and up through the valve to the atmosphere, or any receptacle containing pressure less than that of the steam. The trap is manufactured by W. T. Garratt & Co., San Francisco, Cal.

A Cincinnati man makes the following statement to a reporter for *The Enquirer*: "I was invited to select a tree, which I did, and it was cut down for me in the morning. I watched it during the day undergoing the various processes of paper-making, and at 6 o'clock that evening the tree was paper. At midnight a portion of it was sufficiently dry to be taken to a printing office, and a few of the copies of the next morning's paper were printed on this product. From a tree to a printed newspaper in twenty-four hours is probably the best time on record."

Blnaway—And young Blower, the fellow who was always boasting that he would yet do something to arouse the country. Whatever became of him?

Stadehome—Manufacturing alarm clocks the last we heard.—*Buffalo Courier.*

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Tariff Settlement and Business.

After months of delay, for which there has never been any good excuse, Congress has finally passed a tariff bill, and it has been in force long enough to enable some opinion to be formed as to its probable practical working. Evidence multiplies to show that the business of the country is rapidly adjusting itself to the new conditions imposed by the bill, and a steady improvement in business both commercial and manufacturing is confidently expected by those whose acquaintance with commercial affairs and freedom from extreme and unreasonable partisanship makes them best able to judge. The bill, as finally passed, probably does not entirely, and in every particular suit a single citizen of the country in any party; it is a compromise, as in fact most, if not all, general tariff bills are and must be, but in this case the especially regrettable feature of the compromise is that impudent rascality and perfidy had to be dealt with and allowed for in the final result.

Now that the feeling of intense exasperation at the unreasonable delay has in a measure passed away, and people have a chance to consider the bill itself, it is seen that the reduction of import duties amounts to about 25 per cent., and that with few exceptions the duty remaining added to the cost of production abroad is more than the prices at which domestic goods have been selling here for some time—prices fixed by home competition.

So far as machinery is concerned the old rate of duty (35 per cent) is retained, except on such as is used for farming operations; and, as agricultural machinery has for some time been a regular and increasing article of export from this country, and the prices at which it has been sold here by our own producers have been fixed by very keen competition, a competition which none but the most efficient establishments have been able to stand, this feature of the bill will, in practice, cut little or no figure, either in its effect upon such manufactures or in prices paid by farmers for farm machinery.

Whether or not this bill as it stands is in the right direction, is a question which time and experience only can answer. It is the law of the land and no possible good can come from mere railing at it, or calling names. It is the duty of every good American citizen—a duty which he owes to his country and to himself, to go to work, attend strictly to business, study, without allowing prejudice to prevail, the tariff question, and be prepared to vote upon it in future in accordance with his honest convictions. And when the people have so voted, it is the duty of every citizen to accept the result, as philosophically as may be.

As we intimated above, it seems to be the general impression, backed up by substantial evidence, that there is going to be a revival of business, and if there is, then machinery interests will get the benefit of it.

The Strike of the Garment Workers in New York.

The AMERICAN MACHINIST has, on general principles, opposed itself to strikes, not with reference to the immediate rights of the contending parties, but because strikes, as we believe, afford no definite settlement of the question, or questions, at issue, any more than two prize fighters settle their moral standing by an encounter. But there is no general rule without its exceptions. The recent strike of the garment workers in New York is, we believe, an exception. There are no general economic conditions that govern the case. The price these workers receive plays no noticeable part in the cost of garments to the public. The whole matter is comprehended in the efforts of middlemen to grind down working men and working women below the possibilities of a decent existence. Every investigation that has been made has shown this to be true. It is private gain against decent living, neither more nor less.

There is an interesting question in connection with this strike. That question is whether or not the people will sustain the strikers. It is said that when workmen are in the right popular feeling is always ready to sustain them. This now remains to be proven. We do not think that there is a single individual in New York who does not believe these strikers have justice on their side.

The men who have been doing this abominable sweating business are not, for the most part, citizens of this country, but this makes no difference; they are subject to the laws of this country, and the laws are not enforced in their case.

These strikers are entitled to the sympathy of the public. Every one knows that they deserve this sympathy. Will they get it? Right is right, upon whichever side it may be.

There is no question of higher prices to the general public. The only question is one of oppression. The price paid the garment workers would astonish those who wear their work by its insignificance. It means nothing to the public. To these workers it means the difference between working 18 hours a day and lying down for three or four hours sleep right amidst the dust of their daily work, consumption always staring them in the face; the difference between that and an hour or two outside their work. There is menace in their way of living, not only to themselves, but to every one who wears the garments they make.

These garment makers in their strike, it may be, are simply taking a stand between two kinds of suicide, slow and quick. We commend them for taking a stand for the possibility of the quick, rather than the certainty of the slow.

Since the above was written there has been a settlement of the strike; the garment workers, as our information goes, securing everything they asked for. As a result of this it appears that the daily hours of labor have been reduced from eighteen to ten. In this strike—if it can be called a strike—the men are reported as saying that they could no longer stand the conditions under which they worked and were compelled to live, and they simply refused to work longer; for which they are to be commended. As in evidence anent what we have intimated as to the small part in the cost of a garment which the price paid for making it cuts, it came out that the making of *eighteen coats was exacted for a day's work.* It would be superfluous to say more on this part of the subject.

It should be mentioned to the credit of a few of the great wholesale dealers in clothing, that they, ashamed of the starvation wages paid by the middlemen, took a hand in settling the trouble by threatening to open manufactories, individually or in concert. We do not know that this is true; we hope it is.

What Will be the Outcome?

Here is something about which comment seems almost unnecessary. It suggests anew the inquiry, "Whither are we drifting?" A railroad company has a right to demand efficient service from its employes, but when it enters into politics in the way indicated it is time for every one to enter the lists in opposition. It is well-known that railroads elect men to office to favor their ends, and that they buy those they do not elect. Now they ask a little more than the world. They want to take in their charge the manhood of the men who work for them. The foregoing comment seems unnecessary. It is unnecessary in the instance of men who consider themselves free. There is room for the expression of any amount of indignation, but it is better to let men read and think for themselves. We clip as below, from a press dispatch, a notice posted by the Union Pacific Railroad. We are quite willing to let it go without further comment:

"On account of the personal strife engendered by partisanship, it has been decided to ask all employes of the Union Pacific Company to refrain from active participation in politics. Should any employe desire to accept the nomination for any office, he will be requested to resign from the service of the company."

Just how far custom will go in establishing what comes to be really considered as a right is very well instanced by down town merchants of New York in their vigorous howl against the police, who, under instructions, are attempting to keep the sidewalks clear to the extent of obliging these merchants to load their trucks immediately from their stores, and unload their goods into their stores, instead of in either case piling them on the sidewalks for hours, which they have been in the habit of doing from time immemorial; been in the habit of doing until they have concluded that they own the sidewalks, and that the police are infringing their rights by ordering them, in relation to their boxes and parcels, to "move on." Pedestrians who have occasion to thread these streets, mostly with extremely narrow sidewalks, will look upon the effort to keep them reasonably clear with something of awe and wonder, as they have long since come to the conclusion that the walks, somehow or other, were sanctified to boxes and bales.

One of the principal arguments in favor of letting the bridge company build just about the kind of bridge they want to build across the Hudson River at New York, without much reference to the present or prospective requirements of navigation, is that if the company cannot do substantially as they like, they will do nothing. As is generally the case in such instances, the company is likely, in the end, to have its way in the matter, leaving the repenting to all future generations. This is the way it always has been, and the way it is always likely to be.

A custom is growing up in this country that cannot fail to have beneficial effects on the future of manufacture. We refer to the practice of great manufacturing houses—and smaller ones that hope to become great—in sending their foremost mechanical men on occasional trips about the country and to Europe to see what others are doing and how they are doing it. Shut out the principal mechanical men from contact with the outside world of machinery and they very soon get into a rut that grows only deeper the more industriously they travel in it. When a great machine shop, for example, gets to be merely an echo of hearsay and a disciple of tradition it will not amount to much. No one can look successfully with the eyes of another.

Judging solely by our own experience, technical journals receive a good many letters relating to supposed inventions of an impossible character, and it is by no means a fact that these communications always come from what are called unlearned people. On the contrary, it is not uncommon to find them coming from men with a college education, who are, we should say, rather apt to flounder quite hopelessly when they take hold of matters outside their profession. Engineers not infrequently find themselves consulted—hardly ever under cover of a retaining fee—by men in other professions in regard to some point in engineering or mechanics, and about as often find a stupendous ignorance of the matter on the part of those who expect, as a matter of course, to have their views endorsed. As an example, an engineer was approached by a rather eminent physician in regard to the principles involved in the operation of a common steam engine, he wishing to use the inferences to be drawn from his conclusions to adorn a lecture he was to deliver before a society of learned doctors of medicine. He showed by the statement of his proposition not only a colossal ignorance of the whole subject in its technicalities, but he seemed unable to apply the most common laws of physics to the matter, and finally gave up in despair with the remark that he would skip what

he had written in that direction. This lack of versatility—or, perhaps, unfounded belief in its possession—accounts for the comparative ease with which rich, educated men are led to invest in the stock of companies that propose some plain impossibility. It is not generally the so called ignorant that are entrapped in this way, but those whose education, one would suppose, would lead them to detect the fraud.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(421) A.C., Montreal, asks: Will you kindly inform me how to silence the exhaust of a 4″x4″ high pressure engine? *A.*—You can probably do this by a suitable arrangement of some one of the exhaust heads sold by dealers.

(422) J. H. C., Boston, Mass., asks: Who makes the engine that is used by J. H. to illustrate his article on patternmaking in your issue of August 31, 1893? *A.*—We do not know. Some one in England, if it ever existed outside the author's brain.

(423) J. G. B., Welland, Ont., writes: Please inform me as to the most complete treatise on the steam engine, considered from the standpoint of its highest and modern development. I wish to get a standard work which will aid me practically in the design of the same, and one which will develop formulas as well as state them. I have had a technical education, so you will understand the type of work I wish to obtain. *A.*—"Manual of the Steam Engine," by Prof. R. H. Thurston, and 'Steam Engine Design," by J. M. Whitham, may suit you.

(424) C. R., Altoona, Pa., writes: Please give me a rule to find the taper on a lathe with taper attachment. For example, say, a piece is 8¼″ long, and is tapered for 5″ of its length. The diameter at large end of the taper is 1.283″, and at the small end 1.026″, what is the taper per foot? *A.*—The length of the piece may be disregarded in computing the taper per foot, and the problem may be stated in the form of simple proportion, because the difference in diameter between the large and small ends will bear the same proportion to the length of the tapered portion as the taper per foot bears to 12″. Stating it thus, we have the proportion for this case, 5″ : .257″ : : 12 : .6168″, the last figure being the taper per foot. In other words, we can solve such problems by multiplying the difference in diameter between the large and small ends by 12″, and dividing by the length of the tapered portion of the work.

(425) H. E. B., Newark, N. J., writes: Kindly inform me if a die or any raised design used for stamping sleeve buttons or similar work will be liable to greater injury when engraved on the sides of a bar of steel than when engraved on the end, or a cross section of the bar. There is a difference of opinion in regard to this between two parties. A. claims that it makes no difference on which part or side of the steel bar the design is engraved. B. claims that the pressure brought to bear on the die will injure the design to a greater extent when engraved on any of the sides of the bar than when engraved on the end, because the steel has the grain running lengthwise like wood, and since it is more difficult to separate the fibers of wood by giving it a blow on a cross section than when struck on the sides, it follows that the pressure on steel will have a similar effect. *A.*—If the die is made of ordinary bar steel, then B. is correct. But for expensive dies the steel should be made specially for the purpose.

(426) L. W., Philadelphia, Pa., writes: I have to make a drawing of a cast iron steam separator of rectangular form, braced by vertical ribs, as shown on the accompanying sketch, Fig. 1. Kindly inform me how to proportion this side so as to withstand a given pressure. I have looked through text books, but feel uncertain as to the conditions of loading and the right rule to use. *A.*—The simplest way will be to consider the side as made up of a number of ⊥ beams uniformly loaded. Midway between the ribs *R*, *R*, *R* draw the lines *a b* and *c d*, the distance between them will be the width of the flange of the ⊥ beam whose strength has to be computed. The first step will be to compute the distance *c*, that is, the distance from the neutral axis, which passes through the center of gravity of the cross section, to the fiber most remote from it. This distance is found by the following formula:

$$c = \frac{\frac{1}{2} t\, d^2 + f\,(b - t)\,(d - \frac{1}{2} f)}{t\, d + f\,(b - t)}, \quad (1)$$

the distances to which the letters refer are clearly shown in Fig. 2. To show the application of this formula we will assume numerical values for the letters. Let the depth *d* of section = 3¾ inches, width *b* of the flange = 6 inches; thickness *f* of the flange = ⅝ inch, and thickness *t* of the web = ⅝ inch; substituting these values for the letters we have

$$c = \frac{\frac{1}{2} \times \frac{5}{8} \times 3\frac{3}{4}^2 + \frac{5}{8} \times (6 - \frac{5}{8}) \times (3\frac{3}{4} - \frac{1}{2} \times \frac{5}{8})}{\frac{5}{8} \times 3\frac{3}{4} + \frac{5}{8}\,(6 - \frac{5}{8})}$$

which gives us 2¾ inches for *c*. Let us assume that the length of this beam is 24 inches, then to find the load uniformly distributed which this beam can support with safety, we use the following formula:

$$W = 8 \times \frac{S \times I}{l \times c}. \quad (2)$$

In which *W* = load in pounds, *S* = the safe stress per square inch on the outer fiber, for which we shall take 6,000 pounds, *l* = length of beam in inches, 24 inches in this

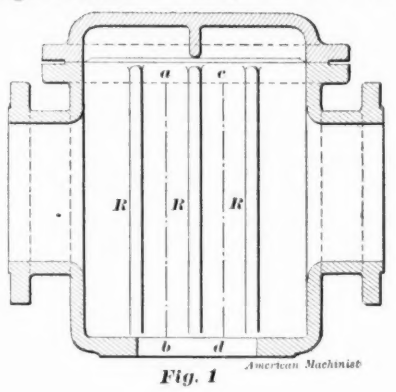


Fig. 1

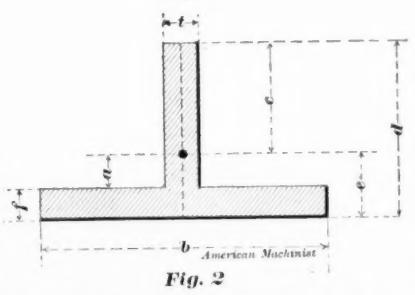


Fig. 2

case, *c* = distance from the neutral axis to the most remote fiber, which we have found to be 2¾ inches, and *I*, the moment of inertia of the section of the beam. The value of this is found by formula (3):

$$I = \frac{t\, c^3 + b\, e^3 - (b - t)\, a^3}{3}; \quad (3)$$

the quantities to which the letters refer are indicated in Fig. 2. Substituting for these letters their values as previously given we have

$$I = \frac{\frac{5}{8} \times 2\frac{3}{4}^3 + 6 \times 1^3 - (6 - \frac{5}{8}) \times \frac{1}{4}^3}{3};$$

this gives us 7.17 for the value of *I*. Substituting for the letters in formula (2) their values we have

$$W = 8 \times \frac{6\,000 \times 7.17}{24 \times 2.75} = 5{,}214.$$

This shows that the beam will support a uniformly distributed load of 5,214 pounds. But this load is, according to the assumed dimensions, distributed over an area of 24 × 6 = 144 square inches, consequently the load or pressure per square inch will be $\frac{5{,}214}{144}$ = 36 pounds. Hence the side in question of the separator will stand with safety a steam pressure of 36 pounds. Formulas (1) and (3) are applicable to all ⊥-sections, and formula (2) is applicable to all forms of cross sections, and to beams uniformly loaded.

(427) H. B. H., Cleveland, O., writes: Recently I designed a crane hook to lift 40,000 pounds. After it was built several draftsmen had a discussion as to its strength, and one who has had considerable experience in different parts of the country stated that it was too large for the work required of it. In calculating the dimensions, the assumed fiber strain was 12,500 pounds per square inch. The material that it was made of was soft steel of about 60,000 pounds tensile stress per square inch. I inclose drawing of hook, giving dimensions, etc. Applying the formula as given on page 441 of "Unwin's Machine Design," 13th edition, the fiber stress in tension is 11,924 pounds per square inch. The formula referred to is as follows:

$$f = P\left(\frac{1}{A} + \frac{l\, y}{I}\right) \quad (1)$$

in which

f = stress per square inch.

P = load supported by hook in pounds.

l = distance in inches from center of hook to neutral axis of cross section.

y = distance in inches from neutral axis to farthest fiber.

I = moment of inertia of section *a b*.

A = area in square inches of the section *a b*.

Substituting values, we have

$$f = 40{,}000\left(\frac{1}{33.18} + \frac{7.25 \times 3.25}{87\,6}\right) = 11{,}924.$$

Professor Reuleaux in his "Constructor," as translated by Suplee, says: "The case is one of combined resistance, and leads to unexpectedly large dimensions." By applying the formula given there I find the hook is too small in the body. By considering the hook as a beam loaded at one end, and whose length is equal to *l* = 7.25 inches, and applying the following formula:

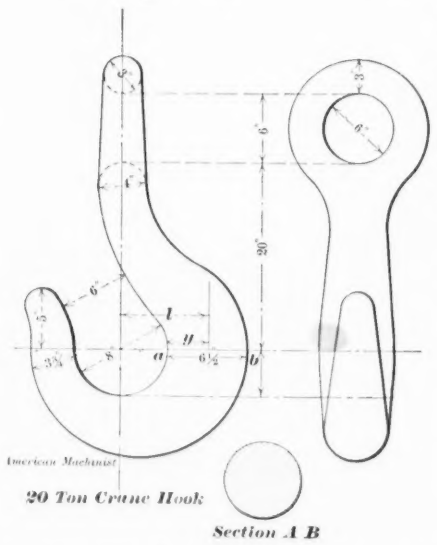
$$f = \frac{M\, y}{I}, \quad (2)$$

in which *f*, *y* and *I* represent the same quantities as before, and *M* = bending moment = 40,000 × 7.25 = 290,000 inch pounds, we have

$$f = \frac{290\,000 \times 3.25}{87.6} = 10{,}759 \text{ pounds}$$

for the stress per square inch on the outer fibers due to bending. We also have a stress *P* = 40,000 pounds which is distributed over the entire section, and the stress due to this load is equal to $\frac{P}{A} = \frac{40{,}000}{33.18}$ = 1206 per square inch, and to get the total stress per square inch of section we have 1206 + 10,759 = 11,965 pounds. This agrees very well with Unwin's method, but comparing this hook with others used in practice, we find this hook would be good for twice the above calculated load. I know that the section adopted is not of the best form for the body of the hook; a better section would have been what is called a flat oval, of a proportion $\frac{b}{d}$ = .6 to .8, *b* and *d* representing short and long diameter respectively; but there were reasons for making the hook of the cross section shown. I would like to have your opinion of this hook. Is it too large for the load? Are the formulæ given in our text-books to be relied upon? Or, is this a case of where theory and practice do not agree? Any light that you can give on the subject will be appreciated. *A.*—The section *a b* has to resist a combined stress due to a direct pull of the load, and that due to the bending moment. This is plainly shown by Unwin's formula (1). If in this formula we remove the brackets, we have

$$f = \frac{P}{A} + \frac{P\, l\, y}{I}. \quad (3)$$



20 Ton Crane Hook

Section A B

The first term $\frac{P}{A}$ of the right hand member of the equation gives the stress per square inch of the section *a b* due to the direct pull of the load, it is equal to $\frac{40{,}000}{33.18}$ = 1,205 pounds per square inch of section, fraction neglected. The second term $\frac{P\, l\, y}{I}$ in the right-hand member of the equation (3) gives the stress per square inch on the outer fibers of a beam whose length is equal to *l* = 7.25 inches, loaded at one end, and supported at the other. In the last formula, the distance from the neutral axis to the fiber most remote from it is represented by *y*, but the section being circular the distance *y* is equal to the radius of the section. For simplicity let us replace *y* by *r* which denotes the radius in inches, hence instead of $\frac{P\, l\, y}{I}$ we shall write $\frac{P\, l\, r}{I}$. (4)

The moment of inertia *I* of a circular section about its diameter is equal to $\frac{\pi\, r^4}{4}$ in which π = 3.1416. Substituting this value for *I* in formula (4) we have

$$\frac{P\, l\, r}{\frac{3\,1416\, r^4}{4}} = \frac{4\, P\, l}{3.1416\, r^3} \quad (5)$$

Substituting the given values for the symbols in formula (5) we have a stress of

$$\frac{4 \times 40.000 \times 7.25}{3\,1416 \times 3\,25^3} = 10{,}756 \text{ pounds}$$

per square inch on the outer fibers due to the bending moment *P l*. Adding this to the direct pull of the load per square inch of the section, we have

10,756 + 1 205 = 11,961 pounds

for the total stress per square inch on the outer fibers of the section *a b*. For good steel this stress per square inch can be greater and still be within the limits of safety, we should not hesitate to allow 16,000 pounds per square inch. From this it appears that your hook is somewhat heavy for the work it has to do, but the error is on the side of safety. We have always used formula 3 for designing hooks of this kind, and have found that theory and practice do agree.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gears, Lex'n, Phila., Cleve'd. See page 12.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Turret Drills, 6 spindles. A. D. Quint, Hartford, Ct.

"National" Lathe Chucks. Best made, page 15.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

Air Compressors for every possible duty. Clayton Air Compressor Works, 26 Cortlandt street, N. Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

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"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton avenue, Philadelphia, Pa.

Model Locomotives. Complete sets castings N. Y. Central Standard up to date. Rough or finished. G. H. Olney, 163 Herkimer St., B'klyn., N. Y.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

Grinders' Supplies—Emery, emery wheels, grinding machines, knife powders and sharpeners, paste and liquid polish, whetstones, etc., etc.; quick process and large stock. Customers annoyed by the delays due to long processes and small stock can get goods in a hurry by buying of The Tanite Co., N.Y. City, Cincinnati, O., and Stroudsburg, Pa.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

A New Method of Compound Steam Distribution.*

BY F. M. RITES, PITTSBURGH, PA.

At the last meeting of the National Electric Light Association in Washington, a committee on data read a very interesting report, from which the following extracts are taken:

"It is somewhat unfortunate that it is the duty of this committee to procure and report facts instead of fancies. We listen

* Presented at the Montreal meeting of the American Society of Mechanical Engineers.

here to many fine economies and ingenious methods of saving, and if we could report what a given installation ought to do theoretically, instead of what it does do practically, we could render a report more in keeping with the progressive spirit of these meetings.

"We are requested, however, to furnish this convention with the facts regarding the amount of coal used in actual practice to produce a given amount of electricity. The information was obtained by correspondence and furnished the committee in amperes, volts and hours on each circuit, and the amount of coal used covering this period, including that used for banking fires, etc. The aggregate electrical output for twenty-four hours was then calculated and compared with the total amount of fuel used, giving the Watt-hours per pound of coal. All improbable and apparently erroneous reports were discarded, and tabulated statement herewith comprises intelligent replies from a large number of the electric stations, including many of the leading corporations.

"The great saving in operating large units is plainly shown in the report; . . . the best results do not compare favorably with the results secured in generating power for manufacturing purposes.

"In order to facilitate this comparison we have prepared a table based on 90 per cent. mechanical efficiency in the engine and the same efficiency in the dynamo.

"Then $\frac{(746 \times .90 \times .90)}{(\text{coal per hour})} = \text{Watt-hours}$ per pound of coal.

"From this estimate of engine and dynamo loss one and one-half pounds of coal should produce 402.24 Watt-hours. We have a report from the Chelsea Jute Mills, of Brooklyn, N. Y., covering a period of six days, where an average of 653 3 indicated horse power was developed from a coal consumption of 1.482 pounds per indicated horse power.

"If our percentage of efficiency is correct, and if we could have a fairly uniform electrical output, this plant ought to be able to produce over 400 Watt-hours, or double that of the most favorable report given us, more than double that of the next best report, thirteen times the efficiency of the plant making the lowest report, and between four and five times the average efficiency of the whole report.

"We hope future reports by this committee will show a much better average than 88.4 Watt hours for one pound of coal."

To the first natural feeling of doubt succeeds the conviction that this report is true, and the question arises: Why should it be so? It is impossible that competent engineering ability should be confined exclusively to the manufacturing industries.

It cannot be assumed that the average intelligence of the designers and operators of electric light stations is inferior to that displayed in establishments of different character, and yet the enormous discrepancy between the actual results and those which should be realized surely deserves some attempt at explanation.

It is but proper to note that the committee has chosen the record of a very high duty as a basis of comparison, and that the nature of the exacting service of electric light and street railway plants precludes the possibility of a close approximation to the highest economy under more favorable conditions; but these figures are entirely unexpected, and, incidentally, somewhat ridiculous, considering the energy with which the last per cent. of efficiency of the electric apparatus is insisted on by its users.

Possibly some reason for such a remarkable state of things may be found in the miscellaneous engineering errors which usually follow an ignorantly wasteful policy, but these are as frequently met in other power plants. Perhaps, also, stations improperly proportioned and generally unfitted for economical competition may be found in the list, but these are far from sufficient to account for such universal failure to realize even a moderate degree of efficiency.

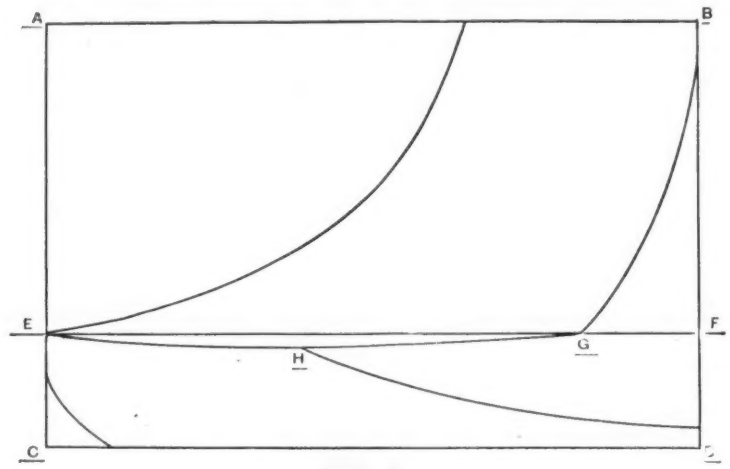


Fig. 1.

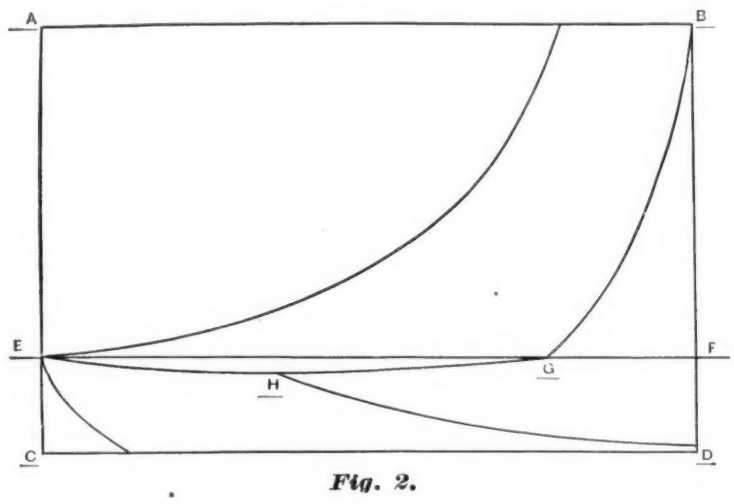


Fig. 2.

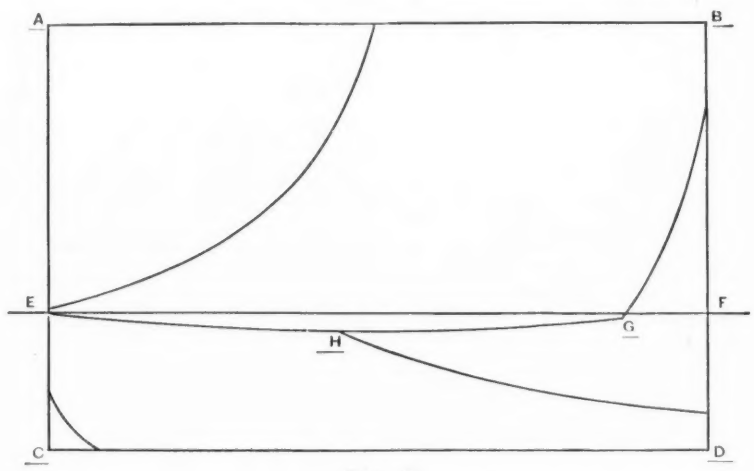


Fig. 3.

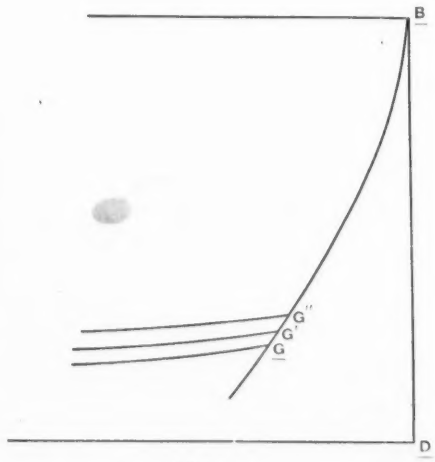


Fig. 4.

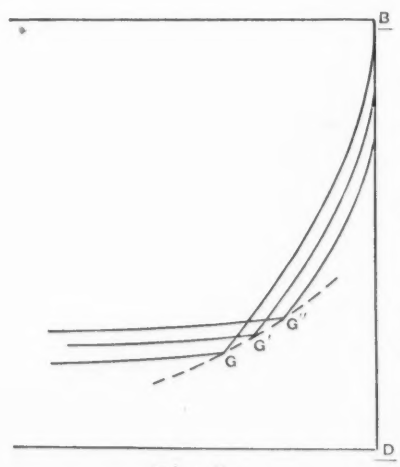


Fig. 5.

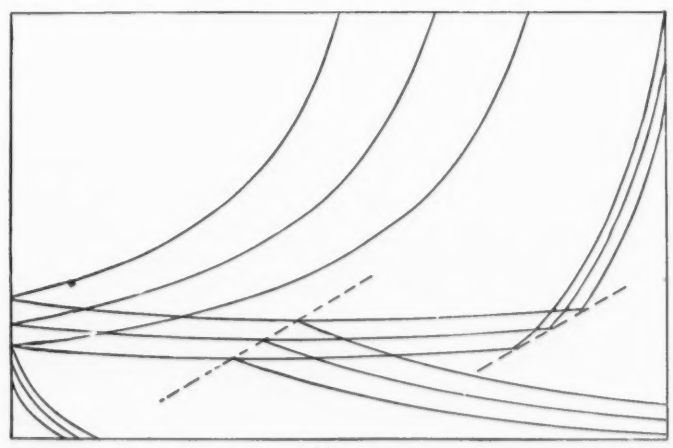


Fig. 6.

There seems to be but one general explanation applicable to electric light or railway stations which can account with any degree of probability for such extravagant fuel consumption, and that is the excessive wastefulness of the steam engine under varying conditions of load.

With the small clearances of the average Corliss engine there is little left for the single cylinder except the proper variation of the cut-off to suit the load, and with the same grade of high speed engine, with its comparatively greater clearance, little more can be expected than a simultaneous variation of all the functions of the steam distribution, after the manner generally adopted. For a multiple expansion engine, however the customer pays a much higher price, and has the right to expect reasonably good results in fuel economy, which, however, he seldom gets in the electric industries.

It is so generally known as to require no demonstration here, that the cause of the increased efficiency of the multiple expansion engine lies in the reduction of cylinder condensation through a proper division of the range of temperature between the cylinders. Hence it is evident that the efficiency can be maintained only with a constancy of the division of the temperature. That this is seldom done is shown by the indications of the receiver gauges of the average multiple cylinder engine in electric power service, where the vacuum frequently passes back through a second receiver.

The indicator card, however, is the complete revelation of the many curious features of abnormal steam distribution which must of necessity lower the efficiency often below that of a simple engine.

Designers have been usually content to provide a mechanism which under approved but seldom available conditions should produce an efficiency to compare favorably with other recorded results; waiving responsibility for failure to maintain that efficiency under varying conditions, and attributing it wholly to the inconstancy or total absence of the requirements.

Recently there has been some interest taken in the subject of uniformity of economy under varying loads, but, with perhaps a single exception, the mechanical designs placed on the market have consisted of minor modifications of existing types rather than the evolution of distinctive features based upon and sufficient for the conditions imposed. Published results with tabulated economies are often misleading by restriction of the range of conditions.

Recognizing the increasing necessity for a design of steam distribution which shall overcome the wasteful tendencies which have been described, the following method has been devised by which the proper division of temperature between the cylinders and the efficiency of the engine may be maintained by means of a uniformly unequal variation of the interdependent valve functions, and which has the advantage of adaptability to almost any existing character of mechanism.

Fig. 1 represents a set of compound indicator diagrams under conditions, as to load, which are assumed to be proper for the highest economy.

Brief attention is called to the points of excellence in these cards in order that the valuable features of the peculiarly varying functions may be appreciated as they are described.

The fall of temperature in the two cylinders is substantially inversely proportional to the surfaces exposed for condensation in the respective cylinders, after due allowance has been made for the relative rapidity of the fall and recovery of the temperature. The compound curves, *E H* and *G H*, representing the division of the temperatures between the cylinders are substantially continuous and show a practically limiting temperature in either cylinder not encroached upon in the other; that is, the lower extreme of temperature in the high pressure cylinder is practically the higher extreme of temperature in the low-

pressure cylinder. All the compression curves, including that into the receiver, approach but do not reach the initial pressures, for in practice it is found unadvisable to correct exactly the loss due to clearance by means of compression on account of a greater secondary attendant loss through displacement of the division of temperature except the engine be condensing.

The following method of constructing these cards in detail will serve to indicate the prominent governing features of the diagrams.

The line *A B* represents the higher extreme of pressure and temperature, and the line *C D* represents the lower extreme, *E F* is the line of division of temperature determined by the proper laws. With a good, generous high-pressure clearance the compression curve *B G* is drawn to a point not higher than *E F* and from *E* and *G*, with a knowledge of clearance and receiver volumes, are drawn the curves *E H* and *G H* to their intersection *H*, which is the point of cut-off of the lower pressure cylinder. The low-pressure and high pressure expansion curves follow as a matter of course, and the low-pressure compression curve may be located independently of the other features of the card, but with due regard for the slight influence it may have on the terminal of the high-pressure expansion curve.

Individual designers may vary the method of the primary construction of the cards without interfering with the essential principles under consideration, so long as the results in practice agree and are high in the scale of engine efficiencies, but the real problem to be solved is the proper manipulation of the cards under varying conditions of load and steam pressure; and a variation of the areas of the cards while maintaining the proper location of the division of temperature between the cylinders. In meeting this problem the ordinary plan of governing through variations of the high-pressure cut-off alone, or maintaining a uniform equality of cut off in both cylinders, is certainly not permissible beyond a very narrow range.

Figs. 2 and 3 represent lighter and heavier loads respectively. With the lighter load the line *E F* falls, and with the heavier load it rises much faster than if both cut-offs were varied alike, but not nearly so fast as if the high-pressure cut off alone were varied. In Fig. 2 it will be noticed that the point *G* approaches the line *E F* and recedes from it in Fig. 3, while the curve *E H* becomes relatively shorter than *H G* as the load decreases. Both compression curves vary in period and degree, and with extremely light loads either may form a loop at its upper extremity. The chief interest centers in the movement of the point *G*, and theoretically it should vary along the compression curve *G B* (see fragmentary card, Fig. 4). Instead, however, of adhering rigidly to this path, the point should follow a slightly different course, as shown in Fig. 5, with the end in view of assisting the proper location of *E F* under the varying conditions of load.

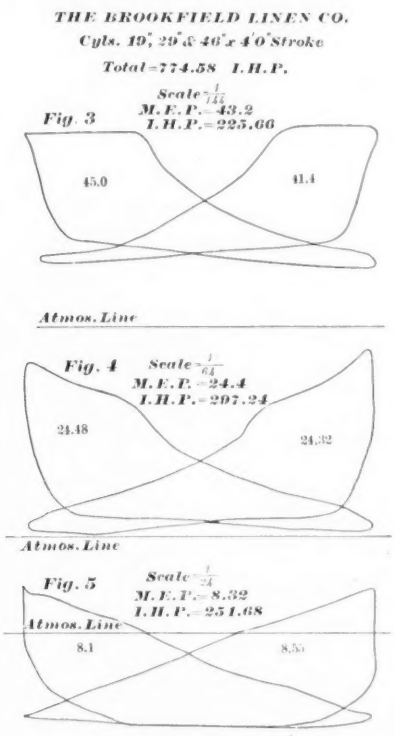
In Fig. 6, all the cards represented in Figs. 1, 2, and 3 are superimposed, and will serve more readily to compare the peculiar features of the similar functions of the valve mechanism.

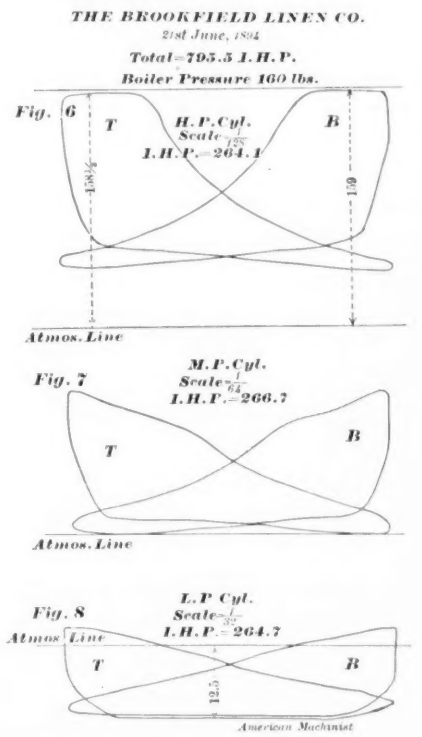
It will appear then that the method consists in a simultaneous variation of all the value functions in the same direction, but with different degree and period, and with particular reference to the position of the line *E F*. Also, that although an exact compression to initial pressure is usually unavailable, except at a single position of governor adjustment, yet the greatest departure from such a degree, which is resultant on this method, is immaterial and is advisable for its beneficial reaction on the position of *E F*.

With a governor controlling all the valve functions, the range of variation of high-pressure cut-off is reduced to a minimum, for the areas of the cards are varied in all directions at once, and incidentally the danger of an engine running away with a light load is avoided.

The above would be incomplete with nothing beyond a mere allusion to the low-pressure compression curve. Convenience would suggest that it be constant in character, but advantage is taken of this opportunity to insist that its point of origin should likewise vary with the other functions of the valves. Such an action serves a double purpose—to assist in the maintenance of the position of the line *E F* while reducing radiation to the condenser or atmosphere with the lighter loads.

If, however, this correction be overdone, as is often the case where a single connection to a shaft governor controls all the valve functions of both cylinders, an excessive loop in the compression curve is formed.





TEST OF 1,000 HORSE POWER TRIPLE-EXPANSION MILL ENGINE.

Cylinders 19 in., 29 in., and 46 in. in diameter by 4 ft. stroke. Suitable for 1,000 indicated horse-power.

	First Trial.	Second Trial.
Date of trial	June 21	June 26
Duration of trial	3 hours	3 hours
Steam jackets	None	None
Sequence of cranks	H. M. L.	H. M. L.
Boilers	2 Lancashire	2 Lancashire
Dimensions of boilers	7 ft. 6 in. × 30 ft.	7 ft. 6 in. × 30 ft.
Diameter of flues	3 ft.	3 ft.
Conical tubes in each boiler	10	10
Economizer, "Green's;" number of pipes	360	360
Heating surface in two boilers	1,900 sq. ft.	1,900 sq. ft.
Heating surface in economizer	3,600 sq. ft.	3,600 sq. ft.
Total heating surface	5,500 sq. ft.	5,500 sq. ft.
Total grate area	70 sq. ft.	70 sq. ft.
Ratio of $\frac{\text{grate surface}}{\text{heating surface}}$ exclusive of economizer	1 : 27	1 : 27
Ratio of $\frac{\text{grate surface}}{\text{heating surface}}$ inclusive of economizer	1 : 78	1 : 78
Class of coal used	Vivian's through and through	
Total weight of coal used	2,428 lb.	2,352 lb.
Total weight of coal used per hour	809 lb.	784 lb.
Coal burnt per square foot of grate surface per hour	11.5 lb.	11.2 lb.
Coal burnt per square foot of total heating surface per hour	.147 lb.	.142 lb.
Total quantity of water evaporated	28,030 lb.	27,320 lb.
Total quantity of water evaporated per hour	9,343 lb.	9,106 lb.
Water evaporated per square foot of grate surface per hour	133.6 lb.	130.1 lb.
Water evaporated per square foot of heating surface per hour	1.70 lb.	1.65 lb.
Water evaporated per pound of coal	11.55 lb.	11.63 lb.
Water evaporated per pound of coal from and at 212 deg.	13.9 lb.	14.00 lb.
Mean steam pressure in boilers	160 lb.	166 lb.
Mean vacuum in condenser (gauge)	27.75 in.	28.25 in.
Mean vacuum in low-pressure cylinder (indicator)	12.25 lb.	12.50 lb.
Mean temperature of injection water	65 deg.	65 deg.
Mean temperature of overflow water	85 deg.	90 deg.
Mean temperature of feed water	60 deg.	59 deg.
Mean temperature after passing through economizer	259 deg.	247 deg.
Mean temperature of steam in boiler	371 deg.	373 deg.
Mean indicated horse-power	787.4	782.7
Mean revolutions per minute	76	76
Mean pressure referred to low-pressure cylinder	25.8	25.56
Net water per indicated horse-power per hour	11.86 lb.	11.63 lb.
Amount of priming, not measured, allow	1 per cent.	1 per cent.
Net dry steam per indicated horse power per hour	11.75 lb	11.52 lb.
Coal per indicated horse-power per hour actual	1.02 lb.	1.00 lb.
Coal per indicated horse-power per hour when feed pumps drawing from hot well and feed water = 280 deg. after passing economizer (calculated)	.99 lb.	.97 lb.
Coal per indicated horse-power on one week's trial of 56 hours, including banking of fires, during meal hours and at night	1.29 lbs.	

On the other hand, if any one of the three compression curves (and these include compression into the receiver) are deficient with the lighter loads, a loop with the low-pressure expansion curve is sure to result.

The designer is thus placed between two fires in this respect; but an error through a loop in the compression curve is of far less consequence than in the expansion curve, and it is by attention to the compression curves alone that an expansion curve loop with its attendant evils can be avoided.

Such a distribution as described may be so designed as to avoid entirely an expansion loop, and it is difficult to understand how the method can be improved; for in each case of readjustment the division of temperature is maintained as perfectly as if the engine while retaining its dimensions, had been purposely designed to meet the momentary conditions. Moreover the principles here involved, instead of being limited to one or two special types, may be readily adapted to any existing character of engine mechanism.

The foregoing is not claimed as an infallible cure for all of the faults of electric light and power stations, but it is firmly believed that reasonable attention by designers of steam engines to the question of maintaining high economy under variations of load will go far towards enabling the committee on data to "make more favorable future reports."

Test of a 1,000 Horse-Power Triple-Expansion Mill Engine.

We reproduce from *Engineering* the engravings of indicator diagrams, and the account of steam engine tests, which show remarkable economic engine performance. The engine was constructed by Messrs. Victor Coates & Co., Limited, of Belfast, for the spinning mills of the Brookfield Linen Company, Limited, of the same town. It was set to work on Monday, September 18, 1893, and has been at work ever since, giving satisfactory results, especially in the matter of fuel consumption and steady driving. As shown by the test, of which we give particulars below, the results attained in this respect are among the best, if not the very best, ever published. It is a matter of regret that the duration of the trials did not exceed three hours, but in a mill it is impossible to run continuously all day with the load on, as the Factory Acts require the meal times to be observed, and the machinery cannot be left in motion without supervision.

The engines are of the inverted type, with A frames under the end cylinders and wrought iron columns under the middle cylinder. The diameters of the cylinders are respectively 19 inches, 29 inches, and 46 inches, and the stroke 4 feet. Each cylinder has 4 Corliss valves, 2 for steam and 2 for exhaust, the former being fitted with Dobson's cut off gear. The cut off motions for the high-pressure and intermediate-pressure cylinders are controlled by a high speed governor, fitted with a Knowles supplementary governor. The first and second cylinders exhaust into spaces between the cylinders, which act as receivers, and the second and third draw their steam direct from these receivers, so that there are no intermediate steam pipes. The cylinders are not jacketed. The crank-shaft runs in 6 bearings, and is built up of 13 parts. Coupled to the crank-shaft is the fly-wheel shaft, carrying a wheel of 15 feet diameter, grooved for 30 ropes of 1¼ inches diameter. On the second motion shaft is a corresponding pulley of 9 feet 6 inches diameter. The air and feed pumps are worked by levers off the center engine, and are completely above the floor line. The piston-rods have United States metallic packing, and the bearings are all white-metaled.

Steam is provided by three boilers, 7 feet 6 inches in diameter and 30 feet long. The shell plates are ⅞ inch thick, the longitudinal joints being double butt-strapped and treble-riveted. The furnaces are of the Adamson type, each made in 13 rings, with 5 Galloway tubes in each. The main steam pipes are of wrought steel, with steel flanges, the bends and branches being cast steel.

We have pleasure in giving herewith the particulars of the remarkable tests made with these engines. The makers guaranteed, under penalty, a consumption not exceeding 12 pounds of water per indicated horse power per hour, and these experiments were carried out for the purpose of verifying whether or not this result had been obtained. It was decided to make two trials, the owners being represented and the trials supervised by Mr. Dobson, their superintendent engineer; Mr. McDowell, their mill manager, and four assistants. The builders in the same way were represented by Mr. Ferguson, manager; Mr. Montgomery, outside foreman, and two assistants. All the arrangements made were carefully inspected during trial by Mr. W. B. Morton, managing director of the Brookfield Linen Company, Limited, and Mr. Henry Coates, managing director of Victor Coates & Co., Limited, and found to be accurate and satisfactory.

Two cast-iron tanks were arranged for measuring the feed water, and connected to feed pumps upon the main engines, so that the water could be pumped from either tank, these tanks being supplied with cold water taken directly from the town's supply. The mode of calibrating tanks was as follows: One tank was partly filled with about 6 inches of water on the bottom, and was fitted with a 6-inch vertical pipe, open at the bottom, and supplied with a float having a lath or vertical guide extending upwards through a slotted cover, the object of the pipe being to arrest vibration and make the readings more accurate. The guide-rod was marked on the top in this position, and 100 pounds of water carefully weighed on a tested weigh bridge and emptied into the tank, this causing the float to rise about 1½ inches. This operation was repeated until 1,800 pounds were measured into the tank. The weighings and markings in every case were checked and passed as satisfactory by representatives of owners and builders. The second tank was calibrated in exactly the same manner and temperature of water taken, namely, 59 degrees.

Three indicators were fitted to the cylin-

ders, each connected to a two-way cock at mid-length of the cylinder for indicating both ends. The indicators were specially made, tested, and guaranteed correct before trial.

The coal was carefully weighed on an adjusted weigh bridge, the tallies and checkings being supervised by each party; this checking also applied to diagrams, in measuring average pressures and all other details, as well as to the levels of water in the tank, when filled and emptied, and the number of tankfuls used; in fact, all measurements and quantities were carefully checked by both sides. To avoid any error brought about by difference of temperature in the feed water, if taken from hot well, it was decided to use the water directly from the town's supply for feeding the boilers. The temperature of this was the same as when the tanks were calibrated, hence the indications given by the floats in the tanks were correct.

Two boilers were used for each trial, there being a third one lying idle. Of the boilers working during the first trial, one had been working three weeks and the other one week, whereas in the second trial one boiler had been working one and a half weeks, and the other two days. We may also mention that during the first day the safety valves were blowing, and a quantity of water was lost thereby, which could not be measured, but this was rectified for the second trial, during which the safety valves did not blow at all. Two high-pressure boilers are used exclusively for driving. Two old boilers, working at 35 pounds pressure and having a separate economizer of their own, of 120 pipes, placed in the flue after the large economizer for the high-pressure boilers, are used for heating the mill.

The coal used was the well-known "Vivian's through and through," and was of very good quality, the amount of ash being small. There is a drain from the drop pipe of the main steam pipe, but this was closed during the trials, any water collected there not being measured, and, therefore, not deducted from the quantities.

None of the cylinders or covers are jacketed, but all are well covered with composition and hair felt and sheet steel. The engines were in their ordinary working condition, and had been running for nine months, the pistons and valves being in good working order.

The three hours of each trial were divided into 18 parts of 10 minutes each, a complete set of diagrams being taken in the middle of each 10 minutes, and the mean of these 18 diagrams is the mean horse-power given. The set of sample diagrams (Figs. 6 to 8) were No. 10 of the first day's trial, and are in every way a fair sample of all the rest, the initial pressure being very close to boiler pressure, vacuum good and well maintained, and the horse-power almost equally divided between the three cylinders. The barometer was high on the second day's trial, and hence the vacuum in the cylinder considerably better.

The amount of water used is remarkably small, being 11.63 pounds per horse power per hour on the second trial, making no allowance for the amount of the priming water in the steam. If this usual deduction be made, the result will give about 11.5 pounds, which we think has not been surpassed.

The coal per indicated horse-power is almost exactly 1 pound, but if an allowance is made for taking water from the hot well instead of town's supply, and getting feed water after passing through the economizer at 280 degrees instead of about 250 degrees, this remarkably low consumption would be reduced to .97 pound per indicated horse-power per hour.

The Brookfield Linen Company, Limited, have also taken a test during one week of 56 hours, the total quantity of coal used, including that used for banking fires at night and meal hours, being 25 tons 10 cwt., and this works out at 1.29 pounds per indicated horse-power per hour.

A Threshing Engine Boiler Explodes.

A Western correspondent sends us a newspaper clipping which gives an account of a boiler explosion at Byron, Ill., by which it appears that at least six persons lost their lives. It is the same old story: A farmer running the engine; water gets low; pump put on, then the explosion. Regarding the management of farm engines, our correspondent writes:

I know men right here [Freeport, Ill.] who when on the road with engines (traction) will "plug" the "pop-valve" and fire up until almost every rivet has a "streak of steam" blowing out from under the heads of them before starting. Now, I consider such work a very dangerous thing to do even by *experienced* men. I do not mean by experienced men, men who are actual engineers, but that class who generally run threshing engines. In time people who own such machines will learn not to employ men who can do everything with their mouth, but nothing otherwise. I do not mean to reflect in any way upon the man who ran this engine, but it is tiresome to hear almost everyone a person meets nowadays telling about when they run engines or what they would do.

I consider a machine, no matter what kind, something like a human being. What can we do if we are not feeling well, all out of sorts and so on? Just so with machinery. What is it doing when only half cared for? and "Oh, let it go, we will fix that some other time," and ere the some other time comes unguilty souls pass into eternity just because someone neglected their duty. People want to know all in a day now. I know how it goes myself. I am a machinist and engineer and will admit that I do not know half as much as I thought I did some six or seven years ago.

A Small Cotton-Seed Press Wanted.

U. S. Senator J. Z. George calls attention to the desirability of a machine for extracting the oil from cotton seed, and so designed that one of the machines can be operated in connection with every cotton gin and by the same engine, whether the gin be upon a large plantation or otherwise. He says there is great need of such a machine in the South, and offers to furnish to inventors wishing to test their devices for this purpose, power, seed, house room, rough labor, etc., at his own plantation in Le Flore County, Mississippi.

The Italians in New Jersey have, so it seems, actually killed a padrone, and no one seems to be so sorry about it as they, perhaps, should be.

MANUFACTURES

A $75,000 electric light plant will be erected at Jacksonville, Fla.

An electric lighting establishment is talked of at Ogdensburg, N. Y.

An electric lighting system will be constructed at Woodbury, N. J.

A cleaning and dyeing plant will probably be established at Spartanburg, S. C.

The city of Cromley, La., will add to its possessions an electric light and water-works plant.

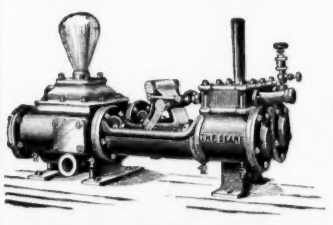
The Dover Cotton-mills, at Pineville, N. C., which are now being enlarged and generally overhauled, will soon have 10,600 spindles in operation.

The New Castle (Pa.) Steel and Tin Plate Co. recently added to its equipment two 18-foot boilers, 84 inches in diameter, and is now running six mills full.

Patterson, Gottfried & Hunter, 146-150 Centre street, New York, issue an illustrated catalogue of the "Reeves" wood split pulley, which they make in a variety of sizes.

The Standard Tool Co., Athol, Mass., issue a new catalogue that illustrates its progress in the way of bringing out new small tools for machinists and mechanics. Catalogue free.

F. E. Reed Company, Worcester, Mass., issue a circular relating to a special wood-turning lathe



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recently brought out by them, and which seems to have some very good features.

Beaman & Smith, Providence, R. I., have issued a new and enlarged catalogue of machine tools, such as lathes, milling machines, and boring machines for general and special work, etc.

It is reported that Hon. C. Estes, builder of the Augusta (Ga.), Canal, will erect a $300,000 cotton mill at Bath, S. C. Beside this mill Mr. Estes may also build a bleachery at Bath.

The converting department at the South works of the Lackawanna Iron and Steel Company, at Scranton, Pa., made in 11 turns during the week ending August 18th, 5,723 gross tons with two 9-ton vessels.

The Bullard Machine Tool Co., Bridgeport, Conn., E. P. Bullard, president, has been incorporated to succeed the Bridgeport Machine Tool Works. The manufacture of machine tools will be continued as heretofore.

The nail, plate-mill and factory of the Ellis and Lessig Steel and Iron Co., at Pottstown, Pa., which were destroyed by fire on June 10th, have been rebuilt and put in operation. The new works are constructed almost wholly of iron.

The Fifield Tool Co., of Lowell, Mass., has become the successor of Geo. W. Fifield, and will continue the manufacture of engine lathes as a specialty. Mr. Fifield retains one third interest in the business, and is president of the new company.

The Brunswick Manufacturing Company has been organized at Portland, Me., for the purpose of manufacturing and dealing in machinery of wood and metal, with $100,000 capital stock. The officers are: President, W. D. Hatch, of Brunswick; treasurer, William M. Pennell, of Brunswick.

A steam saw-mill is soon to be erected at West Cove, on the Lake Shore, a short distance north of the C. P. R. station, Greenville, Me. J. H. Eveleth and the Gerrish Bros. are associated in the enterprise and will operate the mill when completed. The Gerrish Bros. have a saw-mill on the Wilson stream in the eastern part of the town.

The Saco Water Power Machine Shop, Biddeford, Me., has received some new orders, and there is now work enough on hand to insure the shop running all winter. A setting up crew has gone to Lawrence to put some frames into the Everett mills. The shop force has been slightly increased since work started up.

As an indication that the machine business is reviving, we are pleased to note that Thos. H. Dallett & Co., York and Sedgeley avenues, Philadelphia, report more orders for their portable drills during the past month than for many months past. In fact, they consider their past month's sales would make a fair month's business for any ordinary year.

Hallowell, Me., is agitating the subject of a water supply. The Board of Trade have appointed a committee consisting of Mayor Merchant, Samuel G. Otis and Henry P. Clearwater to draw up a petition and obtain signers to request the Mayor and Board of Aldermen to call a public meeting of the citizens to ascertain their views on the water question.

Negotiations are pending for the starting of the works of the Brilliant (O.) Steel and Iron Company. Rumors of the sale of the plant and the reorganization and change of the works to produce other products, have been heard for some time, and it is now thought that changes of some kind will be made and the plant be put in operation by September 1st.

The Speeder Cycle Co., of New Castle, Ind., is a recent corporation organized for the purpose of manufacturing a patent bicycle. They are now erecting quite an extensive plant, and just contracted with the Lodge and Davis Machine Tool Co., of Cincinnati, O., for the entire equipment of same, including engine lathes, turret lathes, screw machines, milling machines, grinding machinery, etc.

A Lawrence (Mass.) paper says that nearly all the local mills are running on full time, and are reported as having orders ahead. The Atlantic, Everett & Pemberton Mills, manufacturing cotton goods, are closed for several weeks, but the upper Pacific is in full operation. The only woolen mill that has closed down in the city owing to stagnation in business is that of Phillips & Kunhardt.

There is talk of Massachusetts parties erecting a large pulp mill in Orono, [Me.] It is understood that the site occupied quite a number of years ago by a saw mill, a short distance from the Orono station, is the one wanted for the pulp mill, and that the privilege has been bonded. If such a mill as proposed is put up about half a million dollars will be expended, which will be a great boom for Orono and a lasting benefit to the town. Orono now has a pulp and paper plant combined, besides the Webster paper mill, but there is plenty of room for more.—*Industrial Journal.*

The *News and Courier*, of Charleston, S. C., shows a condition of things that we believe generally obtain in the industrial conditions of the country. It is just a square stand up to the conditions as they are, and is not probably materially different in Charleston from what it is elsewhere. A flood is always a flood. The *News and Courier* says: In spite of all the calamities and drawbacks, the trade of Charleston shows a falling off of only about $3,500,000 as compared with the preceding year. The aggregate value of the business of the city is more than $71,000,000. The prospects for the new year are full of encouragement. The completion of the jetties makes Charleston one of the finest deep-water ports in the world, and their completion will lead in the near future to the establishment of direct steamship lines to Europe, and to the improvement of the terminal facilities of the port. The paper also publishes letters from correspondents throughout the State showing that the condition of the farmers is better, and they attribute the cause to the forced economy consequent on the disasters of the previous year, and the increased attention to cereal products on account of the low price of cotton.

Machinists' Supplies and Iron.

NEW YORK, September 8, 1894.

Iron—American Pig—We quote standard brands, $12.50 to $13 for No. 1; $11 to $12 for No. 2. Southern brands, $11 50 to $12.25 for No. 1; $10.50 to $11 for No. 2; $10 to $10.25 for No. 3; $10.50 to $11 for No. 1 soft; and $10 25 to $10.75 for No. 2 soft. Foundry No. 4, $9.75 to $10 25.

Antimony—We quote L. X., 8½c. to 8¾c.; Cookson's, 9½c to 10c.; Hallett's, 7¾c. to 8c.; and U. S. French Star, 9¾c. to 10c.

Lard Oil—Prime City we quote at 65c. to 68c.

Copper—New business has been transacted on a moderate scale only, as the larger consumers have bought quite freely a week or so ago, and are now out of the market. Lake Copper can be bought at 9.20c. to 9 25c. Casting Copper is held at 8⅞c, to 9c.

Lead—The market is unsettled; prices have been lowered, but buyers are unwilling to buy. Prime Western lead is quoted at 3 20c., and near futures are rather weak; 3.25c. is about all that could be realized.

Spelter—The market shows a slight improvement, but the demand continues rather slow. Prices have advanced to 3.45c. for New York delivery.

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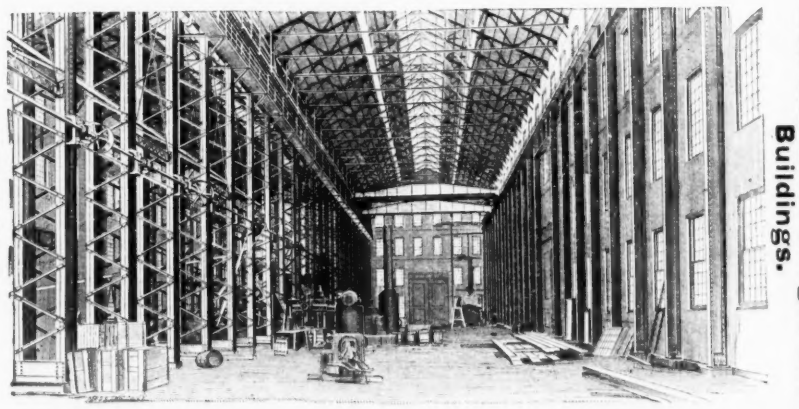

The above material taken direct from a photograph, shows the interior of a Boiler Shop designed and built by us for the Newport News Ship Building and Dry Dock Co., at Newport News, Va. The building is 100 feet in width by 300 feet in length, the width being divided into two parts of 50 feet each, with a row of columns through the center. The entire framework of the building is of iron, with light brick walls around the outside, placed between the iron posts. Hydraulic traveling cranes control the entire floor surface. The building is made very high so as to allow of boilers being removed one over another from one part of the building to the other.

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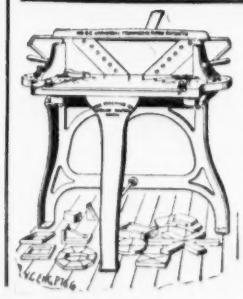

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Le Count's Heavy Steel Dog.
With Steel Screws, Lathe Made and Hardened.
When ordering, state as above, whether a full set or a set of 12, or small set of 8. Users of these dogs prefer them to any other make.
This Dog has a Very Heavy Bow, so that if the thread wears a Heavier Screw can be substituted.

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No.	Inch.	Price.
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3	5-8	.60
4	3-4	.60
5	7-8	.70
6	1	.70
7	1 1-8	.80
8	1 1-4	.80
9	1 3-8	.95
10	1 1-2	.95
11	1 3-4	1.10
12	2	1.20
13	2 1-4	1.35
14	2 1-2	1.45
15	3	1.60
16	3 1-2	1.80
17	4	2.10
18	4 1-2	2.75
19	5	3.25
Full set of 19		$21.60
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One Small Set of 8—by 1-4 inches to 20 inch,		$6.25
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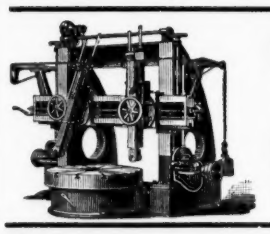

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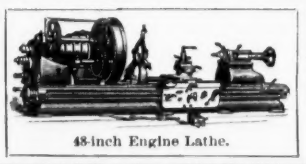

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All common sizes in stock. Catalogue mailed on application.
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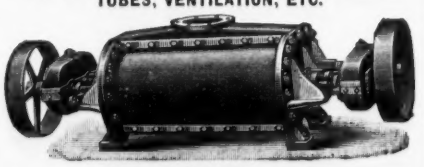

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A mech. eng. and draftsman of 12 years' prac. exp. is open for engagement. F., AM MACHINIST.

Draftsman first-class, wishes position. N. Y. or Brooklyn preferred. Energy, AM. MACHINIST.

Mech. draftsman, 8 yrs' exp. and 1st-class refs., wants pos. P. Anderson, 126 W. Fiftieth st., N. Y.

Draftsman, grad., with 8 years' exp. in steam & gen. mach'y, is open for engage't. H. M., AM. MACH.

Draftsman, grad., 6 years' exp. in eng. and boiler work, wants position. Box 7, AM. MACHINIST.

Young mach., good draftsman, wants pos. under instruction in drawing room Box 11, AM. MACH.

Mech. draftsman, young man, wants pos. Good photographer. Salary low. J. W. F., AM. MACH

Wanted—A first class tool maker. One familiar with milling machine and turret work. Address Box 3, AMERICAN MACHINIST.

A designing engineer with experience on special metal-working machinery and tools, is open for a position of trust. Box 4, AMERICAN MACHINIST.

Wanted—Permanent position as bookkeeper with good firm, 5 years' experience. References A1. Address E. T. I., care AMERICAN MACHINIST.

Situation wanted by thorough machinist as foreman, or to take charge of repairs in mfg. concern; good toolmaker. Address R. P., AM. MACHINIST.

A1 time and cost clerk open for position. Ten years' experience in piecework. Competent to organize system. Best ref. Box 5, AM. MACHINIST.

Wanted—First-class machine tool salesman by leading Chicago house. Address, giving age, experience and terms, Chicago, care AM. MACHINIST.

Wanted—By expert machinist and toolmaker to invest some money & services in a mach. concern in Ohio or surrounding States. Box 6, AM. MACH.

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Wanted—Mech., civil, elec. engrs. or draftsmen, with spare time, well acquainted in their localities. Edwin Guthrie, Corcoran Bldg., Washington, D. C.

Draftsman and vise hand, have some experience in designing, wishes position in drawing room or shop. Address A. B., Box 15, AM. MACHINIST

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Wanted—Position by a thorough mechanic of 17 years' shop and drawing room exp., with inventive and executive ability. Will work in shop or drawing room with a view of filling a position of trust, which, at present, am competent to fill. Correspondence from new enterprises solicited. Boston or East preferred. Address H. J. W., AM. MACH

✢ MISCELLANEOUS WANTS ✢

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Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

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Steen & Hart, Cincinnati, fu nish designs and working drawings of machines.

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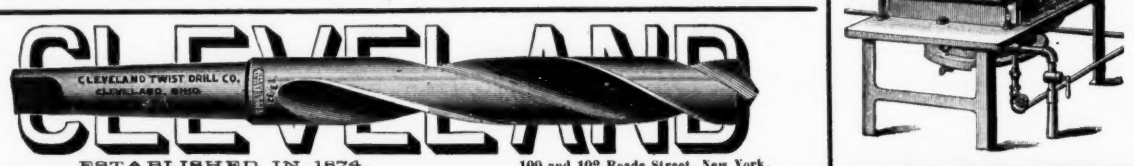

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19 in. x 3 ft. Wheeler.
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24 " x 4 " Wood & Light.
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26 " x 7 " N. Y. S. Eng. Co
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30 " x 10 " Bancroft.
35 " x 7 " Hewes & Phillips.
36 " x 8 " Lathe & Morse.
60 " x 24 " Steam Eng. Co.

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16 " " Gould & Eber.
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3 Spindle Slate Sensitive.
20 in. Swing Wheel Feed.
25 " " Prentice, complete.
26 " " Prentice Friction.
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Radial Drill, 86 in. complete.

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Brainerd Plain Table 30 x 8.
Brown & Sharpe No. 1 Universal.
Lincoln Pattern, very cheap.
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Bement Cyl. Borer, 12 to 36 in.
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13 in. x 6 ft. Blaisdell.
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15 " x 5 " Pond.
15 " x 8 " Standard.
16 " x 6 " New Haven.
16 " x 6 " Ames.
18 " x 8 " Putnam.
20 " x 10 " Fitchburg
22 " x 8 " Harrington.
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Slotters 10 and 18 in. Stroke.
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12 in. Stroke, 16 in. x 16 in. Crank Planer.
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28 " 5 and 8 " "
30 " 5, 8 and 10 " "
60 " 20 " "
72 " 25 " "
9, 12, 16 24 and 26 in. Stroke Shaper.
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Hyd. Rivetting Machine.
" Crane, Both A1.
Punch and Shear.
Plate Planer.
11 in. x 5 ft. Eng. Lathe.
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21 " 10 and 13½ ft. " "
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26 " 10½ " " "
32 " 16 " " "
35 " 13 " " "
52 " 35 " " "
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Bement Car Axle Lathe.
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No. 1, 2 and 2½ Screw Machs. P. & W.
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Hand Millers, Screw Slotters, Mill and Cutter Grinders.

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Price, Size A $1 75, sent post paid on receipt of price.

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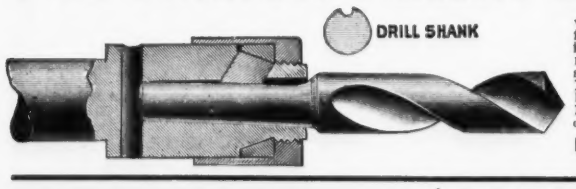
The Andrew Patent Drill Chuck.



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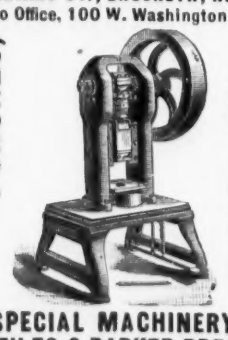

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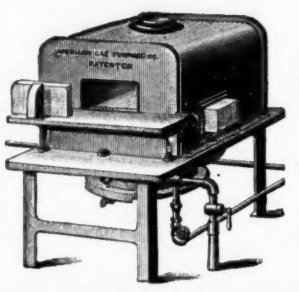

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13 in. x 5 ft. Phenix.
15 " x 6 " Blaisdell.
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16 " x 7 " Bement.
16 " x 8 " Perkins, Taper.
18 " x 6 " New Haven
16 " x 8 " Blaisdell.
18 " x 6 " Bradford.
18 " x 8 " Blaisdell.
18 " x 10 " "
20 " x 6 " Bullard.
29 " x 12 " Fifield.
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24 in. x 24 in. x 5 ft. Putnam.
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SHAPERS.

10 in. Juengst Crank.
10 " Wood and Light Traverse Head.
15 in. Kelly Crank.
18 " Putnam Traverse Head.

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4 10 in. x 41 in. Garvin.
1 12 " x 4 ft. Garvin.
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1 20 " x 6 " Back Geared.

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36 " Gould & Eberhardt Automatic Gear Cutter.
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5 in. Cutting off Machine.
No. 2 Springfield Tool Grinder.
" 1 Garvin Screw Machine.
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Also, a large number of other machines. Write for complete list and detailed description.

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21 in. x 8 ft. Lodge & Davis.
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22 in. x 8 ft. Dietz Gang.
24 in. x 12 ft. Special heavy pattern.
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24 in. x 16 ft. New Haven.
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24 in. x 38 ft. Shafting Lathe.

TURRET LATHES.

3 each 12 in. and 15 in. Lever and Screw Movement to Turret.
3 22 in. x 8 ft. Chucking.

PLANERS.

24 in. x 24 in. x 8 ft. Lodge & D.
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SHAPERS.

15 in. Crank.
20 in. Geared.
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DRILL PRESSES.

20 in. Lever Drill.
24 in. B. G. P. F. Drill.
26 in. Post Drill.
52 in. Comb. Radial.
80 in. Comb. Radial.
120 in. Radial.

MILLING MACHINES.

No. 2 and No. 4 Garvin.
No. 3 Pratt & Whitney Heavy Lincoln."

PULLEY MACHINERY, BRASS WORKING MACHINERY.

THE LODGE & SHIPLEY M. T. CO.,
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Salesman Wanted.

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TAKE THE LEAD.
NO MACHINIST'S OUTFIT
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Book on Gears, 170 Illustrations, $1.00. Job Gear Cutting of all kinds, Spur, Bevel, Spiral, Ratchet, Worm, Rack, Elliptic, Index Plates, Noiseless, Fiberoid Gears, etc. Very small or large. Send for 1894 Catalogue. 1100 sizes of Gears.

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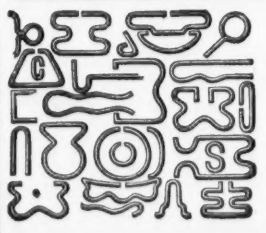

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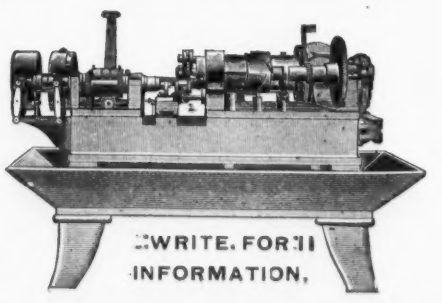

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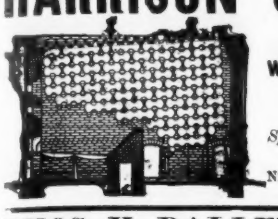

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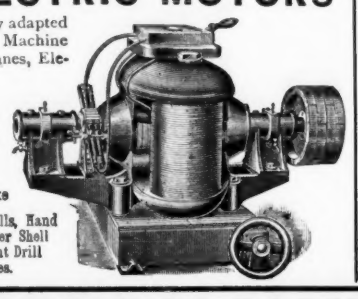

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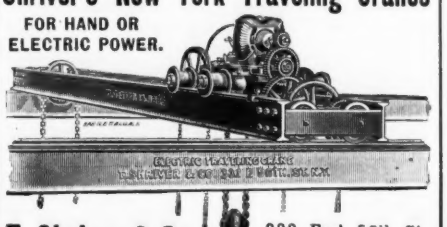

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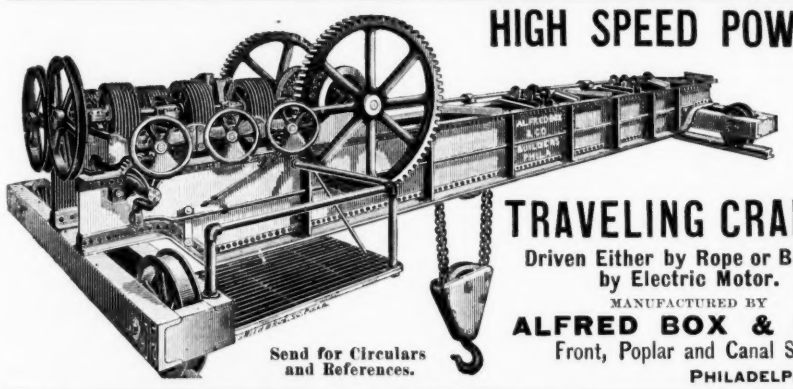

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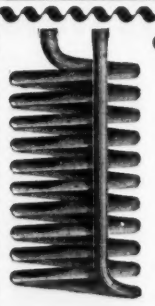

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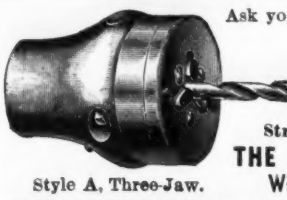

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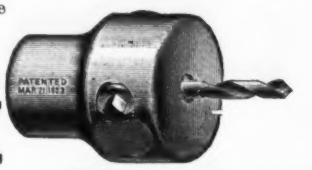

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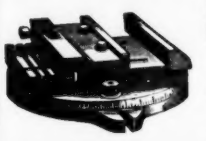

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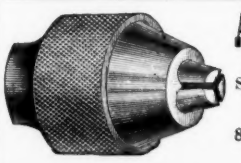

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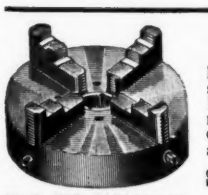

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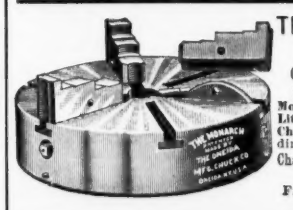

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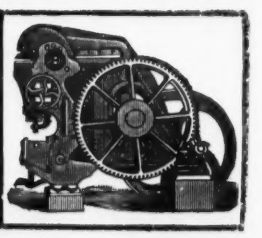

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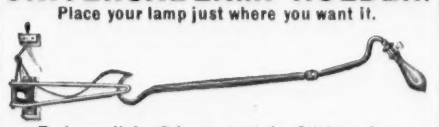

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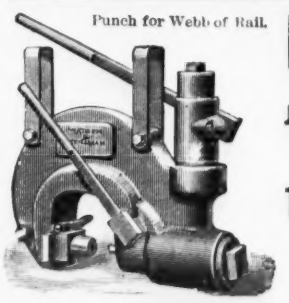

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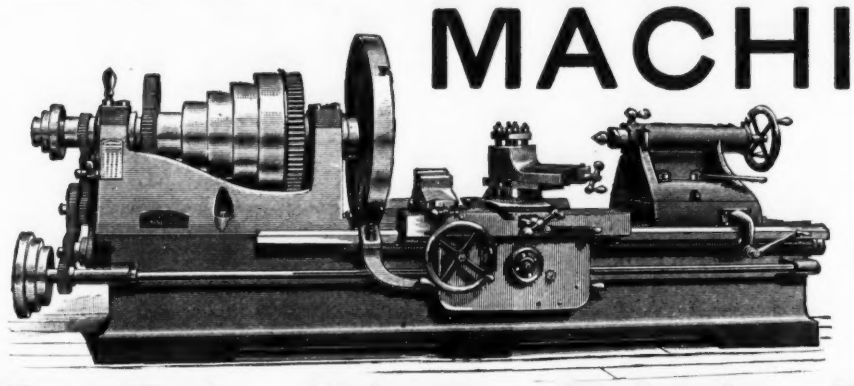

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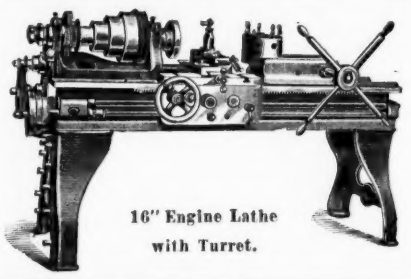

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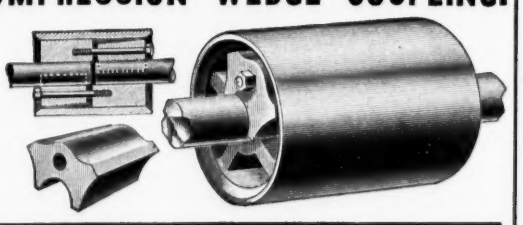

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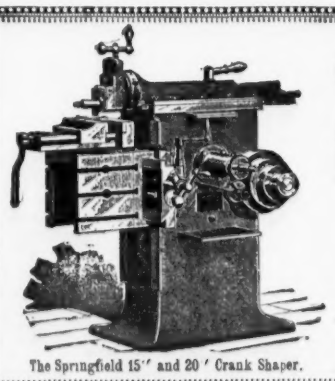

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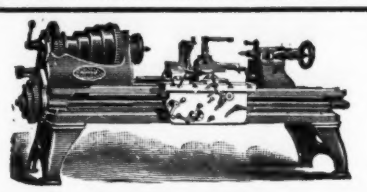

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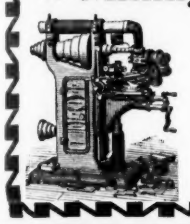

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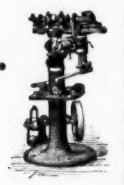

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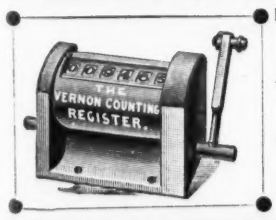

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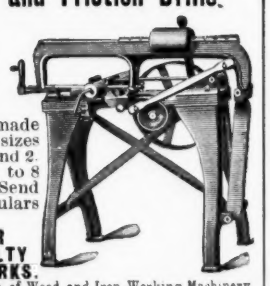

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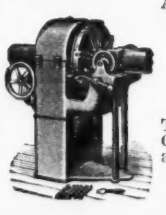

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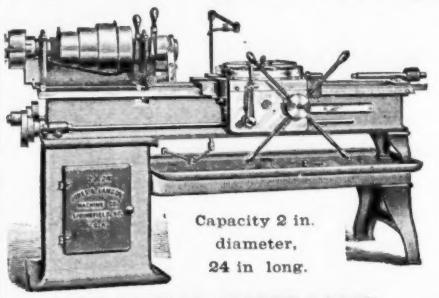

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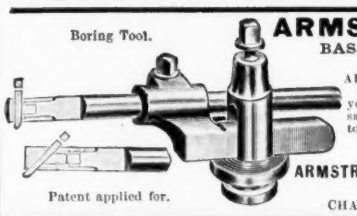

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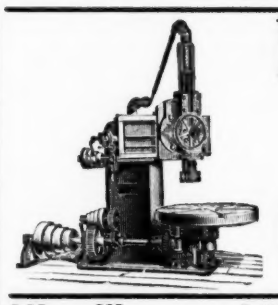

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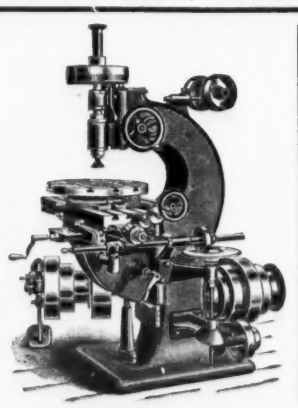

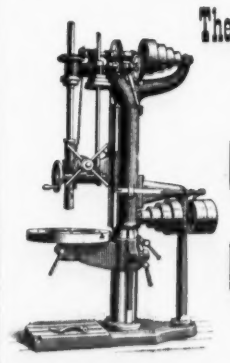

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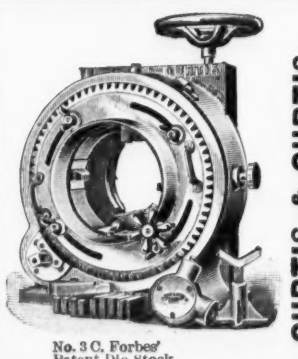

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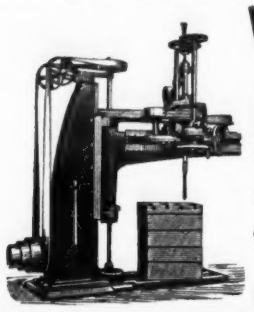

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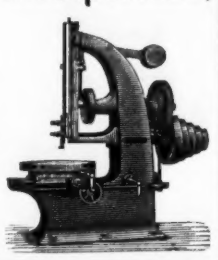

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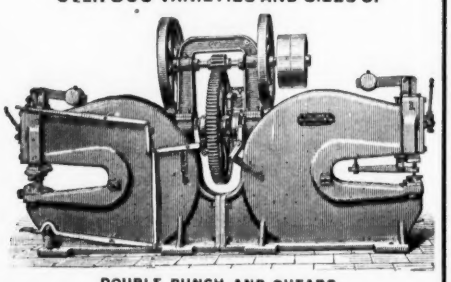

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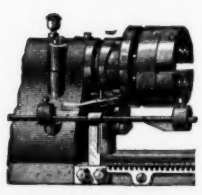

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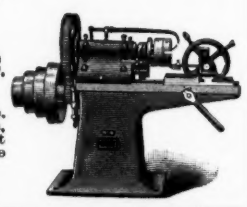

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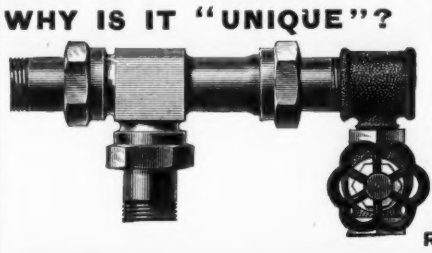

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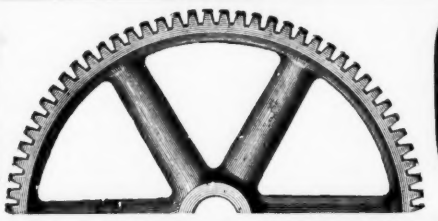

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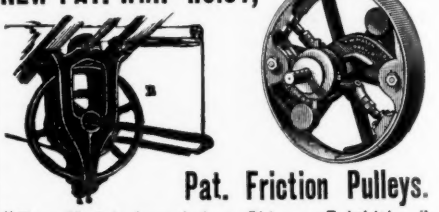

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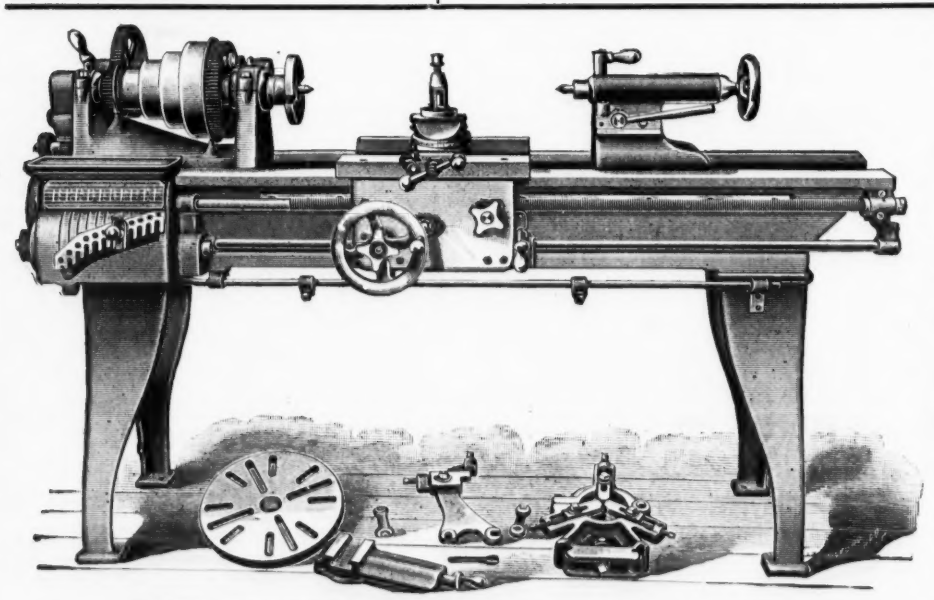

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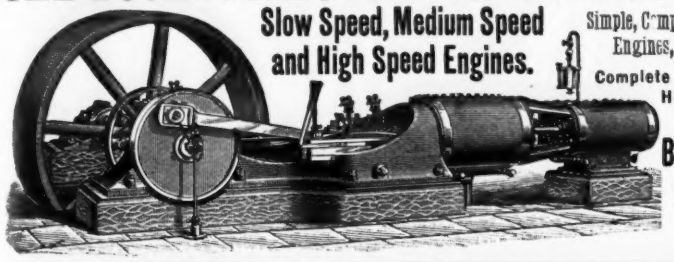

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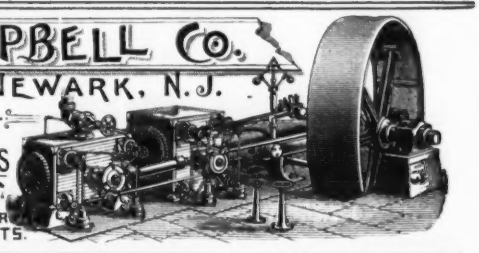

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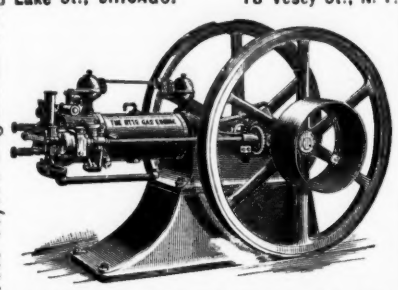

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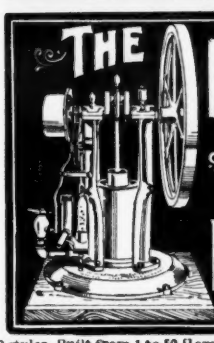

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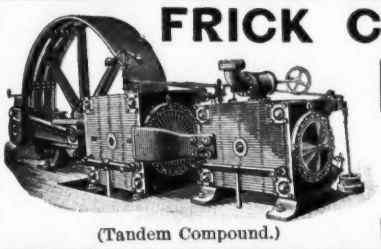

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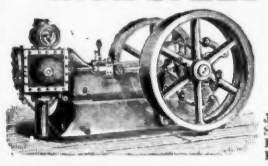

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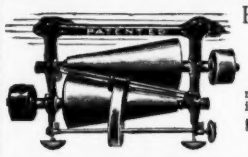

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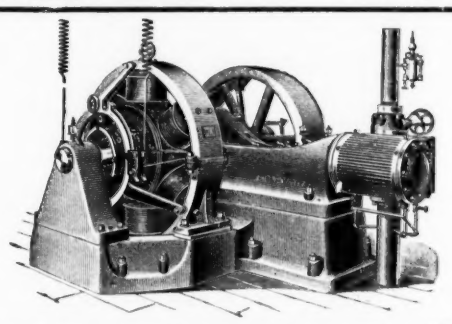

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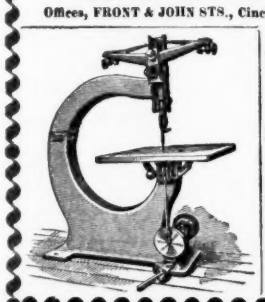

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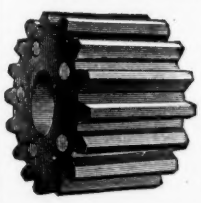

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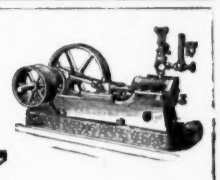

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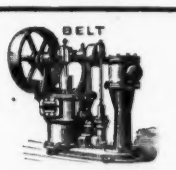

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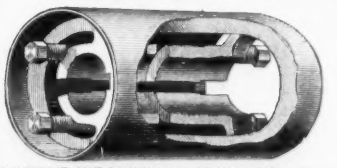

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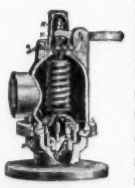

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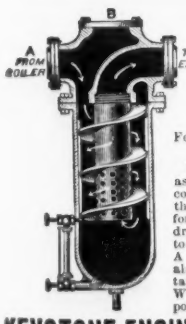

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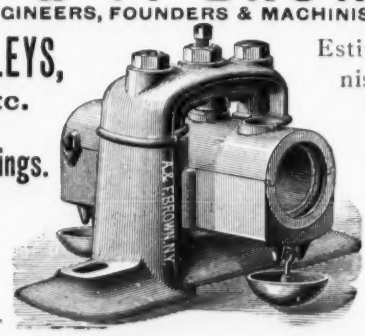

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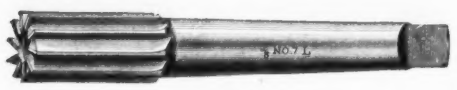

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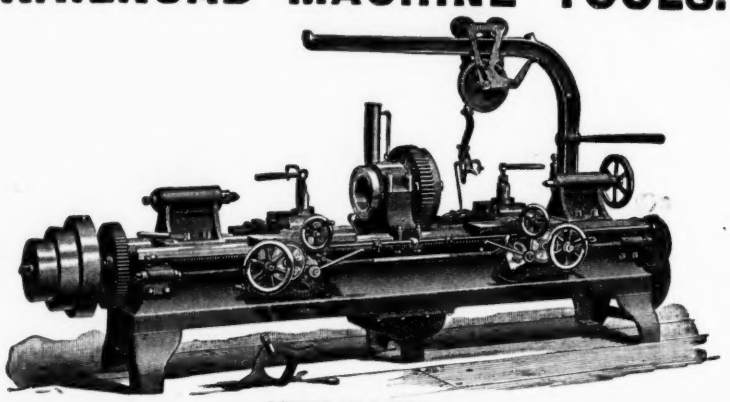

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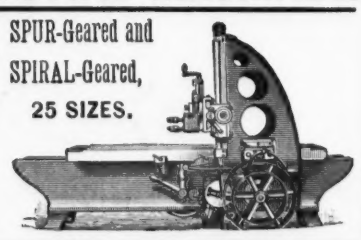

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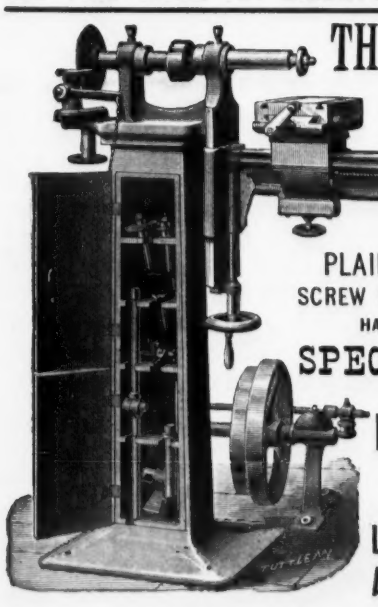

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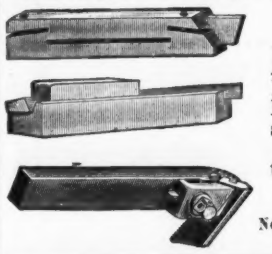

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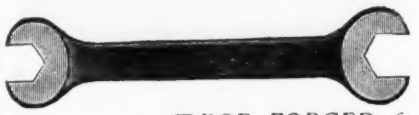

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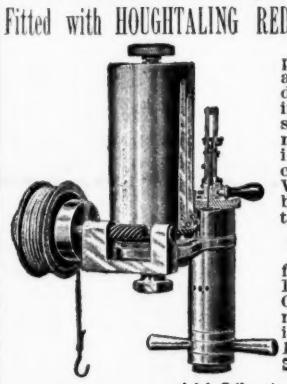

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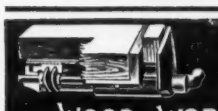

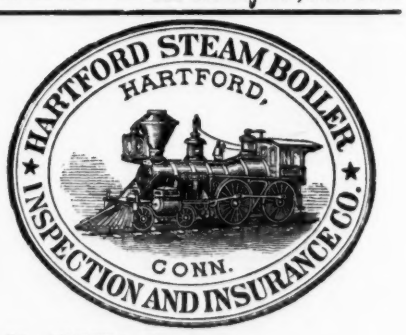

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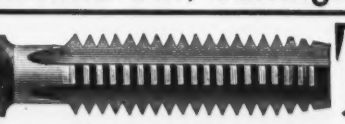

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